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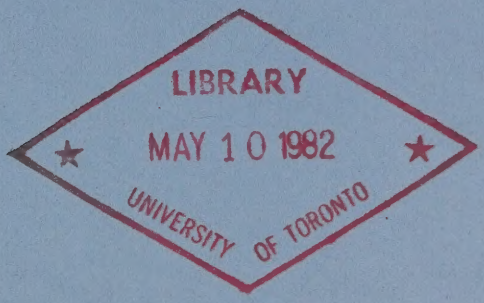
NATIONAL ENERGY BOARD
REASONS FOR DECISION

In the Matter of the Application under Parts I, III and VI of the National Energy Board Act

of



Ontario Hydro

March 1982

NATIONAL ENERGY BOARD

REASONS FOR DECISION

In the Matter of the Application under
Parts I, III and VI of the National Energy Board Act

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ONTARIO HYDRO

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IN THE MATTER OF the National Energy Board Act and the Regulations made thereunder, and

IN THE MATTER OF an application by Ontario Hydro for an Order, a Certificate and a Licence pursuant to Parts I, III and VI of the said Act, filed with the Board under File No. 1923-4/05-7.

HEARD at Ottawa, Ontario on 19, 20, 21, 22, 26 and 27 January 1982.

BEFORE:

R.F. Brooks	)	Presiding Member
J.L. Trudel	)	Member
R.B. Horner, Q.C.	)	Member

APPEARANCES:

Pierre Genest, Q.C. Ian Blue Timothy Pinos	)	Ontario Hydro
Jeffrey Davies	)	The Association of Major Power Consumers of Ontario
J.F. Funnell	)	Manitoba Hydro
Gordon I. Miller, M.P.P.	)	On his own behalf
Bradley Patterson	)	Union Gas Limited
J.M. Johnson, Q.C. M.C. Rounding	)	The Minister of Energy for Ontario
Jean Giroux	)	Attorney General for the Province of Quebec
Walter L. Nisbet, Q.C.	)	Deputy Minister of Environment Canada
S.K. Fraser	)	National Energy Board

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APPENDICES

ABBREVIATIONS USED IN THE REPORT

For Units of Measurement

Btu	British thermal unit
km	kilometre
kV	kilovolt
kW.h	kilowatt hour
GW.h	gigawatt hour
MW	megawatt

For Names

Act	National Energy Board Act
AMPCO	The Association of Major Power Consumers of Ontario
Applicant	Ontario Hydro
Board	National Energy Board
GPU	General Public Utilities Service Corporation
JCP&L	Jersey Central Power and Light Company
NEB	National Energy Board
PASNY	The Power Authority of the State of New York
PJM	Pennsylvannia, New Jersey, Maryland Interconnection
U.S.	United States of America

For Other Terms

AC	alternating current
DC	direct current
HVDC	high-voltage, direct-current

CHAPTER 1
BACKGROUND

Ontario Hydro is a statutory corporation established in 1906 by the Provincial Legislature. It has broad powers to produce, buy, and deliver electric power throughout the province and currently operates under The Power Corporation Act, Revised Statutes of Ontario 1980, c. 384, as amended.

The Corporation's main responsibility is to provide power to municipalities, which in turn distribute the power to their own customers. In addition, Ontario Hydro supplies more than 100 major industrial customers and about 770 000 retail customers in rural areas.

Ontario Hydro has developed an integrated bulk power system in which over seventy generating stations are interconnected with load centres by a network of transmission lines and switching stations. The operating voltages of the lines range from 115 kV up to 500 kV, with most of the lines operating at 230 kV. Peak demand reached 17 211 MW in January 1981. Primary energy demand during 1980 was approximately 100 000 GW.h.

Ontario Hydro owns and operates two power networks, the East System and the West System, which are connected by a double-circuit 230 kV transmission line. A map of Ontario Hydro's major facilities appears in Appendix 1. Appendix 2 shows the capacity of its generating stations.

Ontario Hydro's East System, covering the area east of Wawa to the Quebec border, constitutes the major portion of the Ontario integrated bulk power system. Thirteen ties with Quebec interconnect radially with small sub-systems which are electrically separate from the main system in Quebec or with generation which can be isolated.

The West System, comprising about one twentieth of the load in the province, includes most of the area west of Wawa. It is interconnected with Manitoba Hydro by two 230 kV circuits and

one additional interconnection which can be tied radially to generation in Manitoba to provide power to the Ontario Hydro system on the 115 kV network.

The Ontario Hydro system is interconnected with the systems of The Power Authority of the State of New York, Niagara Mohawk, and The Detroit Edison Company in the United States. PASNY and Niagara Mohawk are participants in the New York Power Pool. Detroit Edison and its neighbouring utility, Consumers Power Company, constitute the Michigan Electric Coordinated System. A list of Ontario Hydro's international power lines appears in Appendix 3. Ontario Hydro operates synchronously with an international electrical network which includes most of the power systems in Canada and the United States east of the Rocky Mountains.

Ontario Hydro currently holds three major export licences which were issued by the Board in 1981. One is EL-134 which authorizes the export of up to 10 000 GW.h per twelve-month period of unscheduled circulating power for simultaneous return to Canada. EL-134 will expire on 31 December 1995. The other two licences, which will expire on 30 June 1991, are EL-135 and EL-136 which authorize the export of miscellaneous firm power and interruptible energy in amounts not to exceed a combined total of 20 000 GW.h per twelve-month period to the end of 1983 and 25 000 GW.h thereafter. Of the total authorization, up to 10 500 GW.h can be exported as miscellaneous firm power under EL-135, subject to the approval of individual contracts by the Board. Two such contracts have been approved to date. One is for the export of 673 GW.h per year to General Public Utilities to expire on 31 December 1983. The other is for the export of various amounts up to 175 GW.h per year to Vermont Public Power Supply Authority to expire on 31 October 1984.

CHAPTER 2
THE APPLICATION

The application, dated 14 May 1981 as amended, requests the following authorizations:

LICENCE

A licence to authorize the export of 1000 MW and 8760 GW.h per year of firm power and energy to Jersey Central Power and Light Company, a subsidiary of General Public Utilities Service Corporation. Actual exports would be subtracted from the quantities authorized for export under Ontario Hydro's existing licences. The term would commence on 1 January 1985 and would run for ten years from the in-service date of the proposed new interconnection described below. Although the licence would authorize a maximum firm power export of 1000 MW, the maximum rate of transfer of the energy would be 1200 MW.

CERTIFICATE

A certificate of public convenience and necessity to authorize the construction and operation of the Canadian portion of a $\pm$ 300 kV direct current interconnection to run some 103 km under Lake Erie. AC switching and DC conversion equipment would be located at Nanticoke Generating Station in Ontario and at Erie West Substation in Pennsylvania. The certificate would also authorize the construction and operation of a ground electrode and ground electrode line.

ORDER

An order to amend Licence EL-136, Ontario Hydro's existing interruptible export licence, to reduce the maximum amount exportable thereunder by the amount exported under the requested licence described above.

CHAPTER 3
EXPORT CONTRACTS

POWER SUPPLY CONTRACT

The export would take place according to the terms and conditions of the Principles of Power Supply Contract of 29 October 1981 between Ontario Hydro and GPU acting on behalf of JCP&L, which forms a part of a letter of intent between the parties. The contract is conditional on receipt of the necessary government approvals, prior demonstration to the satisfaction of Ontario Hydro that financial arrangements can be made to assure timely completion of GPU's portion of the interconnection, and continuing evidence that the interconnection can be constructed within time and cost limits which are acceptable to the parties.

The document states that Ontario Hydro shall sell, and GPU shall buy, firm power and energy. Ontario Hydro would make 1000 MW of firm power continuously available. It would also make up to 8760 GW.h per year of firm energy available, which could be delivered at rates up to 1200 MW.

The Ontario load, and any firm sales committed prior to signing the letter of intent, would take precedence over the export. The export would be supplied from the next most economical generation after supplying these loads.

The term would consist of a pre in-service delivery period and a post in-service delivery period where in-service is defined as the time at which 1000 MW of firm delivery capability is first achieved on the proposed interconnection. The export would be for a period of ten years following the in-service date, unless a delay were caused by GPU financing difficulties. In this case, the term could be shortened at Ontario Hydro's option. The export price would consist of a capacity charge and an energy charge which are described later in this report.

OTHER AGREEMENTS

The parties are currently negotiating a construction agreement and an interconnection agreement. The construction agreement will deal with the relationship and commitments of Ontario Hydro and GPU during the construction phase of the project. The interconnection agreement will deal with the various power and energy exchanges which could occur over the proposed interconnection, in addition to the firm sale described above. It will also cover the maintenance of the interconnection. These agreements will be submitted for the Board's approval when they have been finalized.

CHAPTER 4
THE EVIDENCE: EXPORT OF POWER AND ENERGY

LOAD FORECAST

The Applicant's original submission included long-range and short-range forecasts identical to those considered in the 1981 hearing. Prior to the present hearing, the Applicant submitted a revised set of forecasts. The overall effect of the latest forecast is to reduce the expected long-term growth in peak demand slightly from that predicted in the original forecast.

The Applicant's revised short-range forecast to 1985 is an update of the original short-range forecast based on regional estimates of system customer loads. The revised long-range forecast to the year 2000 is an update of the original long-range forecast and is derived from a judgemental assessment of the results of a number of different approaches. These include a detailed engineering end-use model and several independent econometric models.

The current forecast is for peak demand to grow at an average annual rate of 3.0 percent from 1980 to 2000. In the shorter term, the expected annual growth is 3.2 percent to 1985, 3.5 percent between 1985 and 1990, and 3.1 percent between 1990 and 1995, for an average of 3.3 percent during the requested licence period. The total system peak demand is expected to grow to 27 180 MW in the winter of 1995-96. Energy demand is forecast to reach 161 400 GW.h in 1995. The forecast peak demand for each year from 1985 through 1998 is shown in Appendix 5. Expected annual energy demand is shown in Appendix 6.

GENERATING CAPACITY AND SURPLUS

A summary of the generating capacity available on Ontario Hydro's system appears in Appendix 2. At present, the total nameplate capacity is 24 743 megawatts. Appendix 4 shows the Applicant's generation expansion plan from 1982 to 1998. The planned additions include 5916 MW of uncommitted generation from

1986 to 1998. This uncommitted generation includes 432 MW of supplemental generation consisting of co-generation, district heating, refuse burning and small hydraulic generation, 2084 MW of hydraulic generation and 3400 MW of nuclear generation. In addition to showing uncommitted generation, other changes from the generation expansion plan considered during the 1981 hearing include cancellation of 534 MW of new thermal units planned for 1985 and 1988 and minor changes in in-service dates for some units. The planned additions will increase the capacity to 35 920 MW by December 1995 and to 36 174 MW by December 1998. The net dependable capacity in December of each year of the proposed export period is shown in Appendix 5.

The application states that Ontario Hydro's strategy for long-range generation development envisages building hydraulic and nuclear generation in advance of its requirement for reliability of supply, when such an advancement would result in lower long-term cost. To support this statement the Applicant provided a two-part report entitled "An Analysis of Long Range Generation Alternatives". The report shows that Ontario Hydro plans its new generation in a manner designed to supply the Ontario load at the lowest long-term cost, taking into account security of supply, diversity of fuel type and objectives of the Ontario Ministry of Energy.

The application states that Ontario Hydro will "mothball" unneeded fossil-fired generating units. This refers to a process whereby the unit is placed in storage after steps are taken to minimize corrosion. Ontario Hydro explained that such units can be returned to operation in a matter of months should the need arise. They are therefore included in the available capacity shown in Appendix 5. The amount of mothballed generation is scheduled to vary from a maximum of 3076 MW in 1985 to a minimum of 2488 MW after 1986.

Appendix 5 shows the surplus capacity resulting from the difference between the forecast load plus the required reserve and available generation for the East and West Systems separately.

Combining the systems gives a total capacity surplus ranging from a high of 6160 MW in 1990 to a low of 2623 MW in 1998. Adding the figures in this manner could understate the expected surplus slightly because the annual peak demands for the East and West Systems do not usually occur simultaneously.

ENERGY BALANCE AND SURPLUS

Ontario Hydro's energy demand and generation capability under dependable streamflow conditions are shown in Appendix 6. Dependable streamflow conditions are defined as the sum of the lowest twelve independent monthly flows recorded over fifty years. A witness testified that an additional 1800 GW.h per year beyond that shown, is available under water conditions which are exceeded 98 percent of the time on a system-wide annual basis. Amounts ranging from 7777 GW.h in 1985 to 10 340 GW.h in 1998 over and above the surplus shown in Appendix 6 would be available under median streamflows.

The energy capability figures shown in Appendix 6 are reduced from what they otherwise would be by two factors. One is expected capacity limitations on the transmission circuits from the Bruce nuclear generating stations. The evidence shows that as the Bruce B Nuclear Generating Station enters service, the existing transmission circuits from the station will become fully loaded. Ontario Hydro estimates that the earliest year by which new transmission can be installed is 1989. This so-called bottleneck effect is taken into account in Appendix 6.

The other factor which will limit Ontario Hydro's generating capability is the Ontario Government's acid gas reduction program. The Applicant filed a copy of an Ontario Government Order in Council dated 14 January 1982 which sets maximum aggregate limits on emissions of sulphur dioxide and nitric oxide from Ontario Hydro's fossil-fuel generating stations. In following this regulation Ontario Hydro will reduce emissions from current levels by approximately 25 percent by 1986 and 50

percent by 1990. Testimony and evidence filed by Ontario Hydro indicates that it intends to comply with the emission limits by installing scrubbers on two 500 MW units at Lambton Generating Station, by installing low nitrogen-oxide burners at its coal-fired stations, by increasing its use of low-sulphur coal, by advancing nuclear generation, and by purchasing hydraulic energy from neighbouring Canadian utilities. The resulting energy availability is shown in Appendix 6.

Under dependable streamflows the expected available surplus energy after supplying the Ontario firm load ranges from 51 080 GW.h in 1985 to 8795 GW.h in 1995. The Applicant stressed that streamflows can normally be expected to be better than dependable, thus resulting in larger surpluses than those shown in Appendix 6.

FUEL SUPPLY

The evidence indicates that Ontario Hydro expects GPU to purchase about 5000 GW.h of energy generated from coal in each year of the contract. A witness testified that Ontario Hydro's coal supply contracts have the capability of supplying between 10 and 16 teragrams of coal per year. A teragram of coal equates to approximately 3000 GW.h. The amount of coal needed to supply the Ontario load will vary between five and ten teragrams per year. Thus, there will be a considerable amount of coal available to generate electricity for exports. Ontario Hydro will purchase coal with lower sulphur content to meet the Ontario Government acid gas emission limits. Testimony showed that the Applicant expects no difficulty in obtaining ample quantities of coal of the required quality and that a specific program to acquire up to an additional three teragrams of lower sulphur coal by 1986 has been finalized.

In addition to exports generated from coal, the Applicant forecasts that GPU will purchase about 2000 GW.h of nuclear energy each year from 1989 to 1995. A witness testified that Ontario Hydro's nuclear fuel program is designed to provide sufficient fuel to operate the nuclear stations to their maximum capability to

serve the base load in Ontario. Nuclear energy would only be exported when the available nuclear capacity is not all needed to meet the Ontario load.

PRIORITY OF CANADIAN LOADS - INTERRUPTIBILITY

The application includes copies of letters to Manitoba Hydro, Hydro-Québec, The Great Lakes Power Corporation Limited, Canadian Niagara Power Company Limited, St. Lawrence Power Company, The New Brunswick Electric Power Commission, and Saskatchewan Power Corporation. The letters included copies of the Principles of the Power Supply Contract between Ontario Hydro and GPU and copies of the application. These letters requested that the recipients indicate whether they had any interest in arranging to purchase the proposed firm export.

Replies to the Applicant's letters were filed at the hearing. While no utility indicated an immediate interest in the offer, two other matters were raised. Hydro-Québec requested that any new licence for the export of power contain two conditions. One would require the export to be interrupted when, in the opinion of the Board, an unforeseen situation had caused or could cause an interruption in the supply of firm power to customers in accessible Canadian markets. The other would require Ontario Hydro to offer, on a yearly basis, the power and energy provided for in the GPU contract to all economically accessible Canadian utilities.

Ontario Hydro proposes to interrupt the export if the power is needed to supply primary loads in Ontario but the export would not normally be interruptible to supply other utilities in Canada.

At the hearing Manitoba Hydro filed a copy of an additional letter it had received from Ontario Hydro and stated that it had no interest in purchasing the power and energy offered to it under the specified terms. However, it requested the Board to review the correspondence and rule as to whether the offer made to it was equivalent to that made to GPU.

EXPORT MARKET

The proposed export would supply the customers of Jersey Central Power and Light Company, a subsidiary of General Public Utilities Corporation. JCP&L provides retail service to about 43 percent of the total area of New Jersey. It also provides wholesale service to five municipalities and a rural electric co-operative corporation. In 1985 JCP&L's peak load is forecast to be about 3280 MW and its annual energy requirement is forecast to be 17 140 GW.h.

GPU is an investor-owned company which owns JCP&L, Metropolitan Edison Company and Pennsylvania Electric Company. The GPU utilities are members of a power pool known as the Pennsylvania, New Jersey, Maryland Interconnection. The 1980 summer peak load for the PJM member utilities was about 34 500 MW.

GPU owns the Three Mile Island nuclear generating station, Units 1 and 2. After the breakdown of Unit 2 in 1979, Unit 1 was taken out of service at the order of the U.S. Nuclear Regulatory Commission. In addition, GPU cancelled the construction of a new nuclear station in JCP&L's service area. The GPU subsidiaries, and JCP&L in particular, now rely heavily on their oil-fired generation and upon purchases from neighbouring utilities.

In addition to enabling the firm sale to JCP&L, the proposed HVDC interconnection would provide Ontario Hydro access to new markets for economy sales and other potential transactions. The expected life of the interconnection is 30 years.

LICENCE LIMITS - QUANTITY AND TERM

Firm Licence

The requested licence limits of 1000 MW and 8760 GW.h per year are based on the Applicant's analysis of its available surplus capacity and GPU's shortfall of generation throughout the mid-1980's and beyond. The overall term would commence on 1 January 1985 and continue until ten years after the date on which the Lake Erie interconnection is commercially available with a transfer capacity of 1000 MW. Although the maximum firm delivery

rate would be 1000 MW, the firm energy could be delivered at a rate up to 1200 MW. The additional 200 MW would be interruptible.

The evidence indicates that a term of ten years is necessary to allow both Ontario Hydro and GPU sufficient time to recover their respective shares of the capital costs. The evidence also indicates that a firm sale is required by GPU to provide a solution to their forecast capacity deficit and a firm sale is required by Ontario Hydro to justify the construction of the interconnection.

Amending Order

The requested amending order would reduce the allowable interruptible export under Licence EL-136 by the amount exported under the present request. This means that up to 30 June 1991, when Ontario Hydro's existing licences expire, the maximum export under EL-136 during any consecutive 12-month period could not exceed 25 000 GW.h, less actual exports under EL-135 (Ontario Hydro's miscellaneous firm licence) and less actual exports under the requested GPU firm licence. In other words, the maximum total export during any consecutive 12-month period up to 30 June 1991 will not exceed the existing authorized limit of 25 000 GW.h.

EXPORT PRICE

Any exports made to GPU prior to 1 January 1985 would be made according to the terms of an interconnection agreement which is being negotiated between the Applicant and GPU. The Applicant stated its intention to seek the Board's approval to include the new agreement under Condition 8 of its existing interruptible export licence, EL-136. After 1 January 1985, firm exports would be priced according to the terms outlined in the Principles of Power Supply Contract which will form the basis of a firm power contract.

Capacity Charge

The export price would be composed of an annual capacity charge plus a charge for energy exported. The capacity charge would be based on a formula which includes take-or-pay and penalty provisions. Each component of the capacity charge formula would

itself be determined from formulae set out in the Principles of Power Supply Contract. The detailed formulae are presented in Appendix 7. A brief description follows.

Annual Capacity Charge = AMC - R - P - Q

AMC is the levelized annual amortization charge for the Canadian facilities. With the estimated as-built cost of $390 million ($1984), expected interest rates, and a 10-year term, AMC would work out to $66.8 million ($1984) per year.

R is a factor to compensate Ontario Hydro for energy generated from coal, or other economically-attractive energy which is made available but not taken by GPU during an Exposure Period. The length of the Exposure Period is to be defined by GPU, but as a minimum would include the weekday hours from 8:00 in the morning to 10:00 at night. It amounts to at least 3640 hours per year and could be larger. R would come into effect during any year in which GPU elected to purchase less than 3640 GW.h of attractively-priced energy made available by Ontario Hydro during the Exposure Period. R would also apply if, during any year, GPU were unable to take deliveries of at least 3640 GW.h due to an outage of its HVDC converter facility. R would range from an estimated high of $44.5 million ($1984) in years in which GPU purchased the full 3640 GW.h, to a low of zero in years in which GPU made no purchases.

P is a factor to compensate GPU if, during any year, Ontario Hydro were unable to make available 3640 GW.h of economically-attractive energy during the Exposure Period. In effect, it would reduce the capacity charge if Ontario Hydro were to supply the export from conventional oil-fired generation or combustion turbines. In the unlikely event that Ontario Hydro were unable to supply any economically-attractive energy during a given year, P would equal AMC and in that year the capacity charge would be zero. In years during which Ontario Hydro made available 3640 GW.h of economically-attractive energy during the Exposure Period, P would be zero.

Q is a factor which would compensate GPU if Ontario Hydro were unable to deliver energy due to generation or transmission deficiencies, including outages of the HVDC converter facilities in

Ontario. Q would range from a high of twice AMC in years in which Ontario Hydro could not supply any energy during the Exposure Period, to a low of zero in years in which Ontario Hydro supplied 3640 GW.h of energy during the Exposure Period. In the event of a failure at the proposed Ontario Hydro HVDC converter station, Q would come into effect. A witness testified that an outage of the converter station of sufficient duration to affect the capacity charge in any given year would be extremely unlikely.

No penalty would be paid by either party in the event of a cable failure.

According to the evidence, Ontario Hydro expects to have no difficulty in supplying 3640 GW.h of energy which would be economically attractive to GPU during any year of the proposed export. The surpluses shown in Appendix 6 include only energy which would be attractive to GPU. Ontario Hydro also expects that at least 3640 GW.h would be purchased annually by GPU. Under these conditions the annual capacity charge would be $22.3 million in 1985, escalating at ten percent per annum. Under expected economic conditions, the value of this charge accumulated over the ten-year term works out to approximately $160 million ($1984).

In the event that Ontario Hydro were to make the energy available but it were not purchased by GPU, the annual capacity charge would equal AMC. The accumulated value of this charge over the ten-year term would by definition equal the capital cost of the Canadian portion of the interconnection.

Energy Price

The energy charge would be based on the split savings formula: Price = $\frac{C + V}{2}$, where C is cost and V is value. If C exceeds V, the price would equal the cost.

For deliveries during the Exposure Period, C would be not less than the incremental cost of Ontario Hydro's coal-fired generation and V would be based on costs associated with modern oil-fired generation in the U.S. If energy were supplied from oil-fired or gas-fired generation, the price would be equal to C

which would be based on the incremental cost at the time of the export with a ten percent markup on the fuel cost. For deliveries outside the Exposure Period, C would be based on the Applicant's incremental cost at the time of the export. V would be the cost of the most expensive generation on line in the PJM power pool with the exception that V would be no higher than the cost of modern oil-fired generation in the U.S.

The incremental cost of Ontario Hydro's coal-fired generation is defined by formulae in the Principles of Power Supply Contract. The definition includes factors to account for incremental maintenance of the generating stations, a share of the costs associated with reducing acid gas emissions, potential taxes, losses in the Ontario Hydro portion of the interconnection, and the prevailing exchange rate. The formulae associated with C and V are set out in Appendix 7.

The application includes a comparison of the export price to GPU with projected bulk power prices to Ontario Hydro's municipal utilities and direct customers. It shows that the export price would be roughly twice the price for bulk power service in Ontario. In addition, the Applicant pointed out that the proposed export was offered to all economically-accessible Canadian utilities but was not accepted.

A comparison of potential alternative purchase opportunities analyzed by JCP&L is provided in the application. Alternatives investigated include purchases of energy within PJM or from the Ohio Valley area of the U.S. The large proportion of energy generated from coal which would be available from these sources makes them economically competitive with the proposed purchase from Ontario Hydro. A witness who is employed by GPU testified that his company prefers the proposed purchase from Ontario Hydro because it expects the availability of surplus coal-derived energy in the U.S. to decline during the 1990's, and because of the firmness and reliability associated with the Ontario Hydro purchase. Other alternatives outlined in evidence include purchases from an oil-fired facility or from a nuclear station, both of which were rejected because of their higher cost.

ENVIRONMENTAL EFFECTS OF EXPORTS

The Applicant filed a copy of Ontario Government Order in Council No. 7/82 dated 14 January 1982 which sets maximum aggregate limits of emissions of sulphur dioxide and nitric oxide from fossil-fired generating stations. According to this regulation, total emissions of sulphur dioxide and nitric oxide from fossil-fired generating stations in Ontario shall not exceed 450 kilotonnes in each year from 1986 through 1989 nor 300 kilotonnes per year thereafter. In addition, annual emissions of sulphur dioxide shall not exceed 390 kilotonnes in each year from 1986 through 1989 nor 260 kilotonnes per year thereafter. Ontario Hydro's estimate of total 1985 emissions of sulphur dioxide and oxides of nitrogen, including those from projected exports, is in the order of 531 gigagrams, about 87 percent of which will be sulphur dioxide.

The new regulation replaces that set out by Order in Council No. 73/81 which was filed at the 1981 hearing. The former regulation set the same aggregate limit for each year as does the current one, but did so by specifying maximum levels for each of sulphur dioxide and nitric oxide respectively. The effect of the change is to allow higher emissions of nitric oxide when accompanied by an equivalent reduction in sulphur dioxide emissions. Testimony indicated that it is now felt to be more important to reduce sulphur dioxide emissions, and relatively less so for nitric oxide emissions.

Ontario Hydro intends to comply with the emission limits by increasing purchases of hydraulic energy from neighbouring Canadian utilities and by increasing its use of low-sulphur coal. In addition, it plans to retrofit scrubbers on 1000 MW of generation and to install low nitrogen-oxide burners on its coal-fired generation. The Applicant's plan to utilize additional hydraulic and nuclear units in the future will also contribute to lower emission levels.

Ontario Hydro stressed that it will reduce its acid gas emissions to comply with the new provincial regulations. A witness testified that if the GPU export were not approved, Ontario Hydro would probably adjust its fuel program to use coal with higher sulphur content in order to reduce costs as much as possible while still remaining within the government limits. Thus, he said there would be little change in Ontario Hydro's emissions from 1986 onwards as a result of the GPU sale. Exports could commence during 1985, before the acid gas regulations come into force. The witness stated that, at most, additional emissions during that year would amount to 50 gigagrams. This figure assumes the maximum sale to GPU which would be possible with the current schedule for constructing the interconnection, and does not take into account the potential reduction of other exports which could otherwise be made under the existing export licences.

The application states that the proposed export would be supplied by increased use of facilities installed to meet Ontario requirements. Thus the environmental impact associated with export sales is confined to the incremental effects of increased output from existing plants.

A number of consultants' studies which analyse data on the environmental effects and social costs of atmospheric emissions are included in the application. A summary of these social cost studies may be found in the following section of this report.

The application states that exports would create an increase in the quantity of heat and cooling water discharged. Cooling water discharges are monitored and controlled to meet the Ontario Ministry of Environment guidelines. The application states that there is no significant adverse effect on the aquatic environment resulting from thermal station operation to meet Ontario demands and that the incremental effects of operation for export would be minimal.

Regarding environmental effects of nuclear generation, the application states that even when operated at maximum capacity, Ontario Hydro's nuclear stations emit radionuclides at only a very

small percentage of the Atomic Energy Control Board safety limits. Any incremental operation for export purposes would not increase radiological emissions above the current level and the additional impact would therefore be insignificant.

Evidence was presented on the provincial and federal environmental regulations to which Ontario Hydro is subject, and the means whereby its system is operated to meet all such regulations. The Applicant stressed that, in the event any environmental standard was in danger of being exceeded, exports would be reduced or cut off completely.

SOCIAL COSTS

The application includes copies of the social cost studies presented during the 1981 application to the Board. Witnesses testified at the present hearing that additional work which has been done since that time does not change their assessments of applicable social costs. Studies dealing with effects of emissions from coal-fired generation on human health, building materials, textiles, water quality, vegetation and animals, and property values, are summarized below.

Human Health

Ontario Hydro's consultants were asked to conduct a survey of the available literature on the effects of air quality on human health, to interpret the literature in relation to the situation in Ontario, and to assess social costs attributable to Ontario Hydro generation. The emphasis in the study was on the effects of the sulphur dioxide/particulate complex because the majority of epidemiological evidence is concentrated in this area. The consultants estimated social costs using three different methods based on the work of Lave and Seskin(1). Lave and Seskin estimated that the total health costs due to air pollution in the U.S. in 1963 were $4.16 billion. In order to relate this data to the Ontario situation, the consultants calculated that Lave

(1) Lave, L.B. and Seskin, E.P., Air Pollution and Human Health. Science 169(3947):723, 1970.

and Seskin's estimate was approximately 0.7 percent of the U.S. gross national product in 1963. By taking a similar percentage of Ontario's 1978 gross provincial product, the consultants arrived at a health burden in Ontario of $640 million due to air pollution from all sources.

The second method used by the consultants was to relate Lave and Seskin's estimate to the total economic burden of ill health in the U.S. Using an independent estimate of the total health burden in Ontario, the authors were able to calculate that the portion attributable to air pollution was some $640 million in 1978. This method resulted in the same estimate as did the first method.

The third method was to use estimates developed by Lave and Seskin for the reductions in the levels of morbidity and mortality from various diseases which would result if air pollution were reduced by 50 percent. The reductions in diseases were then related to Ontario health cost data. This method yields an estimate of $612 million for the total health cost in Ontario due to air pollution.

To relate these estimates to its own operations, Ontario Hydro used a consultant's model which shows that power generation in Ontario is responsible for 1.24 percent of ground-level concentrations weighted by population exposed and toxicity of emissions. The Applicant divided the resulting costs by the generation in 1978 at Lakeview, Lambton, and Nanticoke, and, after allowing for inflation, concluded that the social costs due to health effects are somewhere in the range of zero to 0.26 mills per kW.h ($1980).

Building Materials

Damage to zinc, paint, concrete, building stone, aluminum, copper, nickel, tin, brick and glass used in buildings and structures was calculated using methodology developed by Salmon[2], who related levels of U.S. ambient ground-level

(2) Salmon, R.L., Systems Analysis of the Effects of Air Pollution on Materials. Midwest Research Institute, 1970.

concentrations of sulphur dioxide and particulates to the cost of damage. Ontario Hydro's consultants related Salmon's work to the Ontario situation by calculating Ontario Hydro's contributions to the concentrations of sulphur dioxide and particulates within 30 km of the major coal-fired generating stations. The amounts of each of the materials under study located near the generating stations were then estimated from the annual amounts of each material consumed in the province. From this, potential annual damage to each material due to Ontario Hydro's emissions, was calculated. The amounts were summed and divided by total emissions to calculate costs on a per kilowatt hour basis.

Potential soiling costs were calculated based on the annual cost of cleaning exterior walls and windows of buildings in the areas around major coal-fired stations. The total estimated potential costs from damage and soiling is 0.05 mills per kW.h. As remedial action is not always taken, Ontario Hydro estimated the costs to range from zero to 0.05 mills per kW.h ($1980).

Textiles

The consultants' report on air pollution effects on textile materials assesses the costs of damages to textiles in the areas around Nanticoke, Lakeview, and Lambton generating stations. It concludes that an accurate assessment of the cost of textile degredation and cleaning directly attributable to air pollution, is very difficult due to insufficient scientific evidence. Particulate levels encountered in Toronto may give rise to some excess soiling costs but other factors are much more significant causes of laundering. Costs of air pollution effects on textile materials were estimated to range from zero to $10 million per year from all sources of air pollution. Ontario Hydro estimated that its contribution to these costs, based on weighted averages for the three generating stations, ranges from zero to 0.00035 mills per kW.h ($1980).

Water Quality

This report concerned itself with the quality of inland lakes in the Haliburton-Muskoka area. A previous study determined that the Great Lakes are adequately buffered and are therefore not

susceptible to acidification. The Haliburton-Muskoka study area was chosen because of a number of factors. The study area is on the Precambrian Shield, beyond which lakes are well buffered and not susceptible to acidification. Georgian Bay borders the area on the west. North of Lake Nipissing, Ontario Hydro's contribution to sulphate loading rates were said to be obscured by emissions from the Sudbury area.

The study employed a computerized long-range transport and deposition model which calculated that Ontario Hydro's contribution to acid loading in the study area is approximately 2 to 4.2 percent of the total. The study estimates the value of losses in sport fishing in the area due to Ontario Hydro's operations. It estimates the direct cost attributable to Ontario Hydro's fossil-fired generation to be $1.07 million annually. This equates to an incremental cost of 0.04 mills per kW.h ($1980).

Vegetation and Animals

The consultants' report states that only ozone approaches ambient levels known to be toxic to plants or to affect crop yields. Ozone is not produced by Ontario Hydro generating stations. The consultants reported that long-term studies are required to determine if there are any effects of acidic precipitation on crops but that any such effects appear to be unlikely in light of the existing evidence. The section of the report dealing with animals focuses on possible effects of trace elements. It states that the contribution of generating stations to ambient levels is generally several orders of magnitude lower than ambient air quality criteria. No effect on animals is reported. Ontario Hydro concluded that no damage to vegetation or animals is identifiable and therefore attributed zero social cost in this respect.

Property Values

The consultant attempted to find a mathematical relationship between ambient air pollution levels and property values in Toronto. The report states that no correlation was found.

Summary

The application includes a table in which the social costs from each effect described above are summarized and totalled. The overall social costs attributable to Ontario Hydro's coal-fired generation are stated to range from zero to 0.35 mills per kW.h ($1980) or 0.60 mills per kW.h ($1986). Assuming a sale of 3640 GW.h per year for 10 years, the accumulated value of the identified social costs is approximately $15 million ($1984). The estimate was said to be conservative in that no credit was given for the ameliorating effect of the recent provincial acid gas regulations.

The social costs attributable to the proposed export are not included in the formulation of the export price. GPU would pay a proportional share of the costs incurred in reducing emissions from the Applicant's coal-fired stations. Ontario Hydro maintained that revenues from the proposed export would more than recover all social costs and would benefit Ontario customers by lowering electricity rates.

CHAPTER 5
THE EVIDENCE: INTERNATIONAL POWER LINE

GENERAL DESCRIPTION

The route of the proposed ± 300 kV bipolar direct-current interconnection is shown in Appendix 8. The Canadian AC to DC convertor facilities would be in the switchyard of the existing Nanticoke Generating Station on the shore of Lake Erie.

Under normal summer conditions the throughput of the proposed line would be 1200 MW. The winter throughput could be as much as 1440 MW. Ontario Hydro would use the additional capacity, above that required to supply the firm commitment to GPU, to make additional sales to GPU or other U.S. utilities.

The bipolar circuit would comprise five underwater cables (two cables per pole plus one spare), running about 103 km across Lake Erie, five shore-end cables each about 1.0 km in length at Nanticoke, five shore-end cables each about 0.4 km in length at Coho in Pennsylvania, and 9.6 km of overhead bipolar line in Pennsylvania. The cables would be of the solid mass-impregnated type using technology which was stated to have been proven in existing installations.

The underwater cables would be embedded in separate trenches up to 250 metres apart in the deep water section. The spacing would reduce the likelihood of damage from ice scouring or anchors. Construction methods have not been finalized but the trenches would probably be prepared by dredging in the rocky areas near the shore and by ploughing and jetting in the deeper, soft bottom areas.

Ground electrodes would be constructed at each end of the interconnection to provide an earth return which normally would carry only the small current (10 amperes or less) resulting from imbalance between poles. In the event of a pole failure, the ground return would carry the full pole current (2000 amperes) for a brief period until the switching was rearranged. A schematic diagram of the proposed facilities appears in Appendix 9.

The Canadian and U.S. converter stations would be virtually identical. A witness testified that Ontario Hydro expects the conversion equipment to be available at full capacity at least 98 percent of the time, allowing for forced outages and maintenance.

COST ESTIMATE

Ontario Hydro would pay the entire cost of the Canadian on-shore facilities and one half of the total cost of the cables. A breakdown of the estimated cost to Ontario Hydro for the new facilities is shown in Appendix 10. The total cost is estimated at $390 million ($1984) including escalation and interest during construction. Included in this figure are estimates to cover measures for the mitigation of environmental effects which could result from the interconnection.

CONSTRUCTION SCHEDULE

Construction is scheduled to take place commencing in 1982 with the converter stations and continuing into 1986 or later with the installation of the final cable. Construction of the converter facilities would take approximately two and one half years. Two cables would be laid in each of 1984 and 1985 and one in 1986. To meet this schedule, firm orders for the cables must be placed by mid-1982 to allow sufficient time for their manufacture. According to the evidence, delays in meeting the schedule would result in revenue losses to the Applicant of approximately $100 million per year.

The schedule assumes a favourable decision by the Board early enough to allow for further Ontario Hydro Board of Directors and Ontario Government approvals in April 1982. In addition, the schedule requires that there be prior demonstration to the satisfaction of Ontario Hydro that GPU will be able to finance its share of the project and fulfill its obligations to Ontario Hydro. Testimony showed that GPU would have to demonstrate its financial capability by April or May 1982 in order that the construction schedule could be met.

GPU PROJECT FINANCING

A witness who is employed by GPU described how his company intends to finance its share of the proposed project. The plan includes isolating the project from the risks of the GPU system as a whole through the use of a JCP&L financing subsidiary known as TieCo; using project financing concepts to allow the facilities and contract to serve as security for loans instead of the more familiar technique of employing a utility's general credit; and using the credit of JCP&L's customers to provide the equivalent of equity capital during construction and to assure repayment of debt.

To assist in carrying out its financing plan, GPU has retained the services of an advisory group of banks which includes the Royal Bank of Canada, Citibank and Chemical Bank. Testimony showed that this group and GPU feel the project can be financed if the necessary regulatory approvals can be obtained and through financing assistance for the project on the part of equipment suppliers.

The necessary regulatory approvals include issuance of a licence and certificate by the NEB, issuance of a Presidential Permit for the interconnection by the U.S. Department of Energy, approval by the New Jersey Board of Public Utilities for a JCP&L rate increase to provide funds during construction of the project, approval by the U.S. Federal Energy Regulatory Commission for fast (ten-year) depreciation of the facilities, and approval by the U.S. Securities and Exchange Commission for the formation of TieCo which would own and operate the U.S. facilities. The witness expressed confidence that the required approvals can be obtained in time to place orders for the cables by June or July of 1982.

In respect of the required vendor financing, a witness who is employed by a member of GPU's banking group testified that major equipment manufacturers have been approached and have committed themselves to finance 85 percent of GPU's share of the equipment cost directly to TieCo, without bank guarantees. He said

that this, combined with the granting of the required regulatory approvals, would allow the remainder of the financing to be provided by banks.

ECONOMIC JUSTIFICATION AND ALTERNATIVES

The expected annual sale is greater than 3640 GW.h per year, but even at this level, calculations provided by Ontario Hydro indicate that the sale would recover the $390 million cost of the interconnection in five years and provide a net profit of $555 million ($1984) over the ten-year term. Should the cost of the Applicant's generation increase by 50 percent, the net profit would be $293 million ($1984) after recovering the cost of the interconnection. If an allowance is made for a potential reduction of 2000 GW.h per year in other export sales, and assuming that GPU purchases average 3640 GW.h per year, the cost of the interconnection would be recovered in eight years with a net profit of $114 million ($1984).

A witness testified that Ontario Hydro expects to sell about 5000 GW.h per year of on-peak coal-fired energy to GPU for each year of the contract, and up to 2000 GW.h of off-peak nuclear energy during the 1990s for a total of up to 7000 GW.h per year. With the expected levels of exports and forecast coal and oil prices, Ontario Hydro's profit over the ten-year life of the contract would amount to $960 million ($1984). Measured in current dollars, the revenue would be $7 billion, half of which would be profit. Ontario Hydro's Counsel argued that the revenue and profit would contribute significantly to Canada's balance of payments and reduce the cost of power to Ontario consumers by a substantial amount.

The formulation of the capacity charge is such that even if GPU were to purchase no energy, Ontario Hydro would still recover its share of the cost of establishing the interconnection.

As an alternative to the proposed new interconnection, the Applicant considered utilizing existing international power lines to make the GPU export. Studies by the Applicant show that

there is sufficient capacity to accommodate the proposed export on Ontario Hydro's existing interconnections with Michigan and New York but that the delivery of power to GPU would be limited by the transmission systems of intervening utilities. The studies indicate that upgrading of the intervening utilities' transmission facilities could not be completed in the required time frame.

A direct interconnection between Ontario Hydro and GPU could not be established without a submarine cable system across Lake Erie. Of the routes considered, one would have cut directly across Long Point in Ontario. This route was excluded because of the environmental sensitivity of Long Point which is a wildlife sanctuary and conservation area. Other alternatives considered would have involved considerable land-based transmission and were excluded because of the time required to obtain the necessary rights-of-way. The route that was finally selected represents a compromise based on minimizing both the environmental effects and the cost.

ENVIRONMENTAL IMPACT OF THE LINE

An environmental study was carried out by the Applicant to assess the effects of the installation and operation of the interconnection. The study shows that there would be some interference with the activities of fishermen in the cable embedment zone during construction. If blasting is required some fish mortality can be expected. The Applicant stated that the timing of blasting and other construction activities would be planned to minimize fish mortality and interference during spawning periods. Any effects on other aquatic life would be localized and minimal.

Since the cables would cross several natural gas gathering systems, it would be necessary relocate or temporarily remove parts of the systems to embed the cables. In addition, gas company drillship operations would be curtailed within the cable corridor, although exploration under the corridor could continue with the use of directional drilling. The Applicant stated that

negotiations are presently under way with the affected gas companies to reach agreement on compensation for these effects. An amount to cover the necessary compensation has been included in the cost estimate for the interconnection.

The study indicates that operation of the interconnection would have negligible effects on the aquatic environment, on local communities, and on resources. The magnetic field produced by cables during operation could affect the accuracy of magnetic compasses used by small boat operators. This effect would be minimized by identifying the cable route on marine navigation charts and noting the deviation of compass readings. The evidence indicates that there would be no adverse effect due to decommissioning of the interconnection. At the end of their useful life, the cables would be abandoned in the lake bed.

The Applicant filed a report on the preliminary project environmental requirements. The report sets out a preliminary construction schedule and lists the additional permits relating to environmental matters which would be required. The report is intended to serve as a guide for contractors during the construction and installation phases of the project. According to the Applicant, the report would also serve as a vehicle to advise concerned parties of approval conditions and other matters which may be outlined in the Board's decision.

GROUND ELECTRODE

Ontario Hydro proposes to connect its converter station via an overhead line to an off-site ground electrode. Normally only an imbalance current, limited by design to a maximum of ten amperes, would flow through the ground return. In the event of a fault on one pole, up to 2000 amperes could flow through earth between the U.S. and Canadian ground electrodes until the cables from the faulted pole could be switched into the circuit to serve as a metallic return, thereby allowing operation at half power with no ground current. Operation using the earth return is not expected to exceed 12 cumulative hours per year, on average. The overhead line required to connect the electrode to the converter

facilities would be similar in construction to a conventional 44 kV power line and would probably be routed along concession roads.

The Ontario ground electrode could not be located at the Nanticoke converter station because of possible interference with the operation of the AC facilities. The Applicant commissioned a study to investigate the feasibility of locating a ground electrode within 50 kilometres of the Nanticoke converter station. The study indicates that there are a number of suitable locations, describes the environmental effects of the installation and operation of the ground electrode, and outlines measures that can be taken to mitigate these effects. Guidelines for site selection given in the study indicate minimum acceptable separation distances between the electrode and various underground metallic structures.

The major effects of the operation of the ground electrode are possible interference with certain electrical services and potential corrosion of buried metallic structures including pipelines. For safety of personnel, the electrode would be designed to limit the voltage at the surface of the earth to maximum step and touch potentials of ten volts when the electrode was carrying 2000 amperes. A witness testified that this value is barely perceptible to a barefoot person under the worst conditions.

Electrical services which could be interfered with include the local electrical distribution system and certain types of signalling systems and telephone circuits. Modifications could be made to these services so that the effect of ground currents would be negligible. Adequate separation distances between the electrode site and high voltage transmission lines and railway lines would preclude any adverse effects on these facilities. Sectionalizing and cathodic protection would be applied to pipelines which could be adversely affected by the normal or emergency levels of ground currents. For safety, sectionalizing and grounding of metallic fences in the immediate vicinity of the electrode would be required. The study indicates that there would be no significant effects to other buried metal structures.

The evidence shows that either a shallow ring or a deep rod-type electrode design could be selected. A ring-type electrode would be up to 800 metres in diameter and would consist of an exposed metal conductor embedded in a shallow coke-filled trough. A rod-type electrode would consist of an array of about 12 electrode elements, each extending approximately 60 metres into the earth. The array could be arranged in either a straight line or a rectangle, with the elements interconnected by a buried cable. A rod-type electrode would occupy somewhat less area than a ring-type electrode. The final design would depend on the resistivity of the soil at the chosen site. A witness indicated that once installed, the electrode would be maintenance-free. If located on agricultural land, the site could continue to be used for agriculture after construction, provided large metallic structures were not built within 25 metres of the electrode elements and no agricultural vehicles longer than ten metres were used on the site.

As part of the site selection process, the Applicant stressed that information concerning proposed sitings would be provided to local elected and appointed bodies, local landowners, and pipeline and other companies whose interests could be affected by the installation and operation of the ground electrode. Opportunities to provide input into the selection process would be provided through meetings with interested parties. The response of all interested parties would be considered in final site selection and the Applicant would consult with the owners of potentially affected facilities to identify remedial actions once a site was identified.

Chapter 6
INTERVENTIONS

THE ASSOCIATION OF MAJOR POWER CONSUMERS OF ONTARIO

AMPCO's intervention endorses Ontario Hydro's application on the grounds that the proposed cable would be fully paid for over the ten-year term and that profits from the export sales would serve to moderate domestic price levels to a material degree. The intervention also states that the interconnection would contribute favourably to the reliability of the Ontario Hydro system and that additional unquantifiable benefits would accrue due to the increased export capacity which would result from installing the cable. AMPCO suggested that it might be preferable for Ontario Hydro to attempt to market any surplus nuclear energy in Canada rather than to export it.

MANITOBA HYDRO

Manitoba Hydro intervened saying that, due to the complexity of the pricing of the proposed sale, it had not as yet had sufficient time to fully analyse the proposal. At the hearing, Manitoba Hydro filed copies of two letters it had received from the Applicant and stated that, under the terms outlined in the correspondence, it had no interest in purchasing the power and energy offered to it. It requested the Board to rule on whether the letters constitute an offer to Manitoba Hydro on terms equivalent to those of the proposed export.

THE MINISTER OF ENERGY FOR ONTARIO

The Minister of Energy for Ontario intervened in support of the application saying that the construction of the proposed international power line and the associated export would be in the interests of the Province of Ontario and Canada as a whole, provided that the power to be exported is surplus to Canadian needs, that social and environmental impacts of the construction of the line and generation of the power are fully taken into account, and that an adequate export price is charged.

At the hearing, Counsel for the Minister argued that it had been fully demonstrated that the proposed export meets the above requirements. She also argued that, because Ontario Hydro will comply with the provincial acid gas regulations, it is neither necessary nor appropriate for the Board to attach conditions to the requested licence in respect of atmospheric emissions as requested by the Deputy Minister of Environment Canada.

DEPUTY MINISTER OF ENVIRONMENT CANADA

The Deputy Minister of Environment Canada took the position that approval of the application should be conditional upon the use of adequate pollution control. More specifically, his intervention argued that the export should cause no additional increase in atmospheric emissions and that, if the export is approved, the Board should condition the licence to require that the National Guidelines for New Stationary Sources dated 25 April 1981 apply to 1000 MW of the Applicant's existing generating capacity and that the cost of applying the Guidelines should be recovered from the purchasing utility. A witness for the intervenor testified that he would be satisfied if Ontario Hydro were to install scrubbers on two 500 MW generating units in addition to the two scrubbers already slated for construction.

Witnesses for the intervenor stated that, according to their calculations, additional emissions of sulphur dioxide resulting from the proposed export would amount to 110 gigagrams in 1985 and 68 gigagrams in 1995. Cross-examination established that their calculations were based on multiplying the average emission rates provided by Ontario Hydro for all its coal-fired stations by the maximum possible annual export of 8760 GW.h.

To illustrate its concerns with respect to the effects of acid gas deposition on the environment, the intervenor filed copies of Interim Reports of several of the U.S./Canada Work Groups arising from the United States-Canada Memorandum of Intent on Transboundary Air Pollution.

The intervenor argued that Ontario Hydro's social cost studies either underestimated or left unmeasured certain costs. Witnesses for the intervenor were unable to provide their own estimates of these costs.

OTHER INTERVENORS

Mr. Gordon I. Miller, M.P.P., Union Gas Limited, and the Attorney General for the Province of Quebec filed interventions but they did not participate in cross-examination nor did they present direct evidence or argument at the hearing.

CHAPTER 7
DISPOSITION

The Board has given careful consideration to all the evidence, submissions and argument presented.

APPLICATION FOR EXPORT

Section 83 of the NEB Act requires the Board, in examining an application for an export licence, to have regard to all considerations that appear to it to be relevant. Without limiting the generality of the foregoing, the Board is required to satisfy itself that the power to be exported is surplus to reasonably foreseeable Canadian requirements and that the price to be charged is just and reasonable in relation to the public interest. In addition to the foregoing requirements, another consideration which appears relevant to the Board is the potential environmental impact of the export, and the measures suggested for its mitigation. These considerations are discussed in the following sections of the report.

Surplus

The amount of surplus power and energy which may be available for export is dependent on the Applicant's load forecast and generation expansion program. Ontario Hydro's most recent load forecast has been examined by the Board and found to be reasonable. The current forecast anticipates lower growth than was expected in the previous forecast. A trend to successively lower Ontario Hydro forecasts began in 1974 after load growth began to fall off from its traditional rate of approximately seven per cent per year.

The load growth expected during the 1970's led the Applicant to commit substantial quantities of nuclear generation for construction during the 1980's. In its 1981 decision(3), the Board examined the Applicant's committed generation expansion plan and concluded that the generation is being constructed as

(3) National Energy Board, Reasons for Decision, Ontario Hydro, May 1981

scheduled because the saving in coal costs allowed by increased nuclear generation will result in lower long-term cost to Ontario consumers.

The Applicant's generation expansion plan is uncommitted for the period after the installation of the last unit at Darlington Nuclear Generating Station in 1990. The plan also includes some uncommitted hydroelectric and supplemental generation to be added throughout the period under review. Evidence presented at this hearing, in the form of long-range analyses of alternative generation expansion plans, shows that Ontario Hydro would schedule construction of its generation in order to supply the Ontario load at the lowest long-term cost. It is clear that generation is not being added for the purpose of providing surplus to supply the export market.

In examining the availability of surplus for a firm sale of this nature it is necessary to have regard to both the Applicant's capacity balance and its energy balance. The available capacity, peak load, required reserve, and expected surplus are shown in Appendix 5, which indicates that the Applicant will have substantial quantities of surplus capacity above and beyond the 1000 MW proposed for export even when the Ontario load is at its peak.

Appendix 6 shows the annual energy surpluses which are expected to be available after taking into account the reductions in fossil-fired generation which will be necessary to meet the Ontario Government's acid gas regulations. The surpluses range from a high of 51 080 GW.h in 1985 before the acid gas restrictions take effect, to a low of 8795 GW.h in 1995. All the annual surpluses shown in Appendix 6 are greater than the maximum annual export of 8760 GW.h. An analysis of the export market conditions led Ontario Hydro to conclude that the probable level of purchases by GPU would be about 5000 GW.h per year of coal-fired energy plus any surplus nuclear energy which may become available. The export would be interrupted if the power were needed to supply primary

loads in Ontario. In fact, according to the terms of the Principles of Power Supply Contract, Ontario Hydro could supply as little as 3640 GW.h per year without incurring any economic penalty, aside from lost revenue. Since the figures in Appendix 6 are based on dependable streamflows, and since additional energy will likely be available through purchases of hydroelectric energy from Manitoba Hydro or Hydro-Québec, or through purchases of additional quantities of low-sulphur coal, the Board concludes that the estimates are conservative. The actual surpluses are likely to be larger than shown. The considerable flexibility in Ontario Hydro's energy supply arrangements provides assurance that sufficient surplus would be available to maintain the export even if load growth substantially higher than currently expected should materialize.

The proposed export has been offered to accessible Canadian utilities but has not been accepted. At the hearing, Manitoba Hydro stated that it was not interested in purchasing the power and energy offered to it under the terms specified in Ontario Hydro's letters, and requested the Board to rule whether the offer made to it was equivalent to that made to GPU. In examining equivalence of offers, consideration must be given to differences between the potential purchasers in question and variations in their circumstances. In respect of possible sales to Manitoba or Pennsylvania, one such consideration is the ten times greater distance to Manitoba than to Pennsylvania from Ontario Hydro's East System where the power would be generated. The Board is satisfied that an opportunity has been afforded Manitoba Hydro to explore the possibility of purchasing power from the Applicant under terms corresponding, with due allowance for differences in needs and circumstances, to the proposed sale to GPU.

In its response to Ontario Hydro's letter offering the proposed export quantities, Hydro-Québec indicated that it wished to see any export licence which might be issued conditioned to require Ontario Hydro to re-offer the export quantities annually and to interrupt the export if, in the Board's opinion, it were

required to serve Canadian loads. Hydro-Québec's response did not include justification for these requests nor did Hydro-Québec intervene at the hearing to support them. The Board would not be prepared to include such conditions in the licence under consideration without some compelling reason to do so.

From the fact that the power and energy is surplus to the requirements of Ontario Hydro, and that no other Canadian utility has expressed interest in purchasing it, the Board concludes that the quantities proposed for export are surplus to reasonably forseeable Canadian requirements.

The estimates of surplus power and energy supplied by Ontario Hydro cover the period 1985 through 1998. The Board would therefore require that any licence which is issued commence no earlier than 1 January 1985 and terminate no later than 31 December 1998.

Environmental Impact of Export

The Board notes that the Applicant meets all federal and provincial environmental regulations to which it is subject. It is the Applicant's policy to reduce or eliminate exports in order to avoid exceeding any applicable regulation.

The Board accepts the Applicant's statement that, since radioactive emissions from its nuclear stations are only a very small percentage of the applicable limits, additional operation of nuclear stations to generate energy for export would not have unacceptable environmental impact.

Regarding possible changes in quality of the water used for cooling thermal generation, the evidence shows that Ontario Hydro meets the governmental regulations at all times in order to supply the Ontario load and would not exceed them in order to make exports. Additional generation for export would not result in problems arising from cooling water discharges.

As with other environmental criteria, the Applicant meets all applicable environmental standards regarding airborne emissions from its fossil-fired generation. These include not only local air-quality standards of the Ontario Ministry of the Environment

but will also include the limitations on maximum annual emissions of sulphur dioxide and oxides of nitrogen imposed under Regulation 7/82 of the Ontario Government. Witnesses for the Applicant indicated that Ontario Hydro foresees no problem in initiating the necessary measures to meet the regulations, which overall will reduce its airborne emissions by 50 percent.

The evidence indicates that, in the areas of Ontario most sensitive to acidic precipitation, the Applicant is responsible for but a fraction of the total deposition. Despite this, the Ontario Government and Ontario Hydro have embarked on a program that will see this contribution markedly reduced. The Board considers Ontario Hydro's acid gas emission reduction program a positive step.

Witnesses for Environment Canada estimated that in 1985 the proposed export would create additional emissions of 110 gigagrams of sulphur dioxide. The estimate assumes that 1000 MW would be exported continuously throughout that year. In fact, the interconnection is not expected to be available for full operation until late 1985 at the earliest, although some partial operation may be possible earlier. Based on this, Ontario Hydro's estimate of total additional emissions during 1985 is 50 gigagrams, assuming the maximum possible sale and making no allowance for reductions in other exports under existing licences. Actual additional emissions arising from the proposed export would, in all likelihood, be lower than estimated by Ontario Hydro.

The Board accepts Ontario Hydro's statement that the proposed export would not increase its emissions of sulphur dioxide or oxides of nitrogen in any year after 1985. The restrictions which come into effect in 1986 will place a ceiling on emissions of these substances which will be met whether the export takes place or not. Should the export take place, Ontario Hydro plans to stay within the restrictions by burning increased quantities of low-sulphur coal. Under the terms of the Power Corporation Act of Ontario, the Applicant operates its system to meet the Ontario load at the lowest long-term cost. Accordingly, if the export does not

take place the Applicant would burn coal with relatively higher sulphur content because of its lower cost. In other words, Ontario Hydro can be expected to employ its various emission control options to ensure compliance with the acid gas restrictions in the most economic manner possible, whether the export takes place or not.

It follows from the foregoing that Environment Canada's proposal to eliminate emissions arising from generation for the proposed export, be it by installing additional scrubbers or by any other means, would not reduce emissions below the levels specified by the Ontario Government. Even if the Board were to require that the energy proposed for export be generated with reduced emissions, the energy required to serve the domestic load over which the Board does not have jurisdiction would, for economic reasons, be generated with increased emissions. The net effect on Ontario Hydro's emissions would be nil, but the cost of implementing Environment Canada's proposal would be substantial. The Board is not prepared to condition any licence which may be issued along the lines suggested by Environment Canada. However, the Board would, as a condition of any licence which may be issued, require Ontario Hydro to file a monthly report demonstrating that the export had not caused the Ontario Government's acid gas emission limits to be exceeded.

The Board recognizes the desirability of reducing airborne emissions from coal-fired generation to the extent possible. Only through a comprehensive emission-control program will the problems associated with acidic precipitation be resolved. In the Board's view the proposed export by Ontario Hydro to GPU is consistent with the overall goal of reducing acidic loading on the environment. It is clear that if the export were denied, the energy requirements of GPU's customers would be supplied through increased fossil-fired generation in the U.S. Testimony at the hearing showed that some U.S. fossil-fired generation emits considerably larger amounts of atmospheric contamination for each gigawatt hour generated than do Ontario Hydro's coal-fired stations. Moreover, Ontario Hydro has embarked on a comprehensive

program to further reduce its emissions, a step which the Board hopes will be taken by all contributors to acidic precipitation.

Based on the foregoing, it is the Board's opinion that the proposed export would, if anything, decrease total emissions of airborne contaminants in North America. In addition, Ontario Hydro has made it clear that the export would not, with the possible exception of minor amounts in 1985, increase emissions in Canada. Overall, the Board finds that, from an environmental point of view, approving the export would be compatible with the Canadian public interest.

Social Costs

The evidence in respect of social costs is very similar to that which was examined by the Board in its 1981 report.(4) Witnesses at the present hearing testified in respect of additional work which has been done in the area of social costs since the time their studies were prepared for the previous application. Some additional information is now available but none which caused the witnesses to change their assessments of social costs.

Environment Canada established through cross-examination and argument that Ontario Hydro's studies may leave certain social costs unmeasured. Ontario Hydro's witnesses agreed that the methodology is not sufficiently developed to enable accurate assessment of all such effects. Environment Canada was unable to provide any additional quantification in respect of social costs. In the absence of such additional information, the Board accepts Ontario Hydro's estimates as the best currently available. Some reassurance regarding the uncertainty in this area may be drawn from Ontario Hydro's argument that even if the social costs have been underestimated by a factor of ten, they would still be recovered by the export price.

Export Price

The export price would be determined according to formulae set out in the Principles of Power Supply Contract. This document is to form the basis for a formal power supply contract which the Board would require be submitted for its approval.

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(4) Ibid

The Principles of Power Supply Contract states that the export price would comprise a capacity charge and an energy charge. The detailed formulation of these charges has already been described. The Board's conclusions regarding the overall economic feasibility of the project may be found later, in the section on the international power line. The remainder of this section deals with the proposed export price.

In assessing export prices the Board has developed three tests. Briefly stated, these are that the export price should recover an appropriate share of the costs incurred in Canada, that it should not be less than the price for equivalent service to Canadian customers, and that it should not result in prices in the export market which are materially less than those which would result from the least-cost alternative.

It is clear to the Board that the first test is met. Energy would be priced according to the split-savings formula or, if generated from oil, at 110 percent of the cost of the oil. In addition, a proportionate share of the costs associated with reducing airborne emissions would be recovered. Export profits would more than recover any incremental social costs. It is therefore clear that the cost of generating the energy proposed for export would be fully recovered by the export price.

Regarding the second test, the proposed export has been offered to neighbouring Canadian utilities and has not been accepted. The Board therefore concludes that its second test is met. Furthermore, the composite price of the export power and energy is greater than the composite price of firm supply to Ontario Hydro's industrial and municipal customers.

The evidence in respect of the third test is less clear because there does not appear to be an alternative available to GPU which is exactly comparable to the proposed export. Nevertheless, the Board is satisfied that, when compared with the alternatives that are available, the proposed export price is acceptable.

From the foregoing discussion, and having in mind its findings on the economic viability of the interconnection, the Board is satisfied that the price to be charged for the proposed export is just and reasonable in relation to the public interest.

THE INTERNATIONAL POWER LINE

Section 44 of the Act requires the Board, in considering an application for a certificate, to take into account all matters that appear to it to be relevant. In particular, the Act states that the Board may have regard to the availability of power for the line, the existence of markets, the financing and economic feasibility of the project, and any public interest that may be affected by the granting or refusing of the application.

The availability of power and the existence of markets have been demonstrated in previous sections of this report. The financing of the line would amount to less than three percent of the Applicant's general capital program. The Board is satisfied that Canadians would have ample opportunity to participate in supplying and installing the equipment. The cables themselves, which according to evidence can be manufactured only in Europe, would contain Canadian copper and lead.

The Applicant undertook to submit a copy of its construction agreement with GPU covering construction of the interconnection when it is available. Accordingly, any certificate would contain a condition requiring Ontario Hydro to file the agreement for the Board's approval before commencing construction.

Economic Feasibility

The Board has examined the cost estimate for the proposed interconnection and finds it reasonable. It is clear from the evidence that the cost of constructing the Canadian portion of the proposed interconnection would be fully recovered by revenues from the proposed firm export. In the unlikely event that GPU elects to purchase no energy, the capacity charge would still recover the Applicant's costs. Most probably, there would be a substantial

profit associated with export revenues which would serve to reduce prices to Ontario customers. In addition, the interconnection, over its expected 30-year life, would improve the reliability of Ontario Hydro's system by providing access to additional sources of support during emergencies and would also provide access to new markets for interruptible sales.

One concern identified by Ontario Hydro, which is shared by the Board, regards the ability of General Public Utilities to finance its share of the project. Extensive evidence was presented which sets out the required steps for GPU financing. The project is conditional upon Ontario Hydro being satisfied that financing has been successfully arranged. The Board would condition any certificate to require that the demonstration of financing on GPU's part be supplied by Ontario Hydro for the Board's approval prior to the placing of major orders for equipment.

Environmental Impact

The Board is satisfied that the interconnection can be installed and operated with minimal environmental impact. Any impact would be reduced by scheduling construction to avoid periods of high biological activity. In addition to NEB approval, the Applicant requires a number of permits from various government agencies dealing with such things as the use of explosives for blasting, the effects of the project on navigation, and dredging and spoils disposal. The construction schedule and the requirements for additional approvals are set out in a report on the preliminary project environmental requirements which was filed at the hearing. The Board, as a condition of any certificate which may be issued, would require that updates to the preliminary project environmental report, and evidence that the necessary outstanding approvals had been received, be submitted for its approval.

Ground Electrode

The location of the ground electrode, which would form a part of the international power line, has not yet been selected nor has its design been finalized. Extensive evidence was filed

regarding the procedure for selecting a site for the electrode and the measures which would be taken to mitigate the effects of ground currents. The Board is satisfied that a suitable site can be located.

Ontario Hydro stressed that the siting of the ground electrode would involve considerable opportunity for public participation and input from potentially affected parties. Accordingly, the Board would condition any certificate it might issue to require that Ontario Hydro file for the Board's approval its proposed program for involving the public in the selection of the site, and to require that construction of the ground electrode not commence until the Board had approved its final location and design.

THE BOARD'S FINDINGS

Having taken into account all matters that appear to it to be relevant and having determined that the proposed export quantities are surplus to reasonably foreseeable Canadian requirements, that the export price is just and reasonable in relation to the public interest, and that no unacceptable environmental impact would result, the Board finds the export to be in the public interest. Accordingly, the Board is prepared to issue an export licence to Ontario Hydro subject to the terms and conditions set out in Appendix II. Subject to Governor in Council approval of the new licence, the Board will issue an order amending Licence EL-136 to reduce the quantities exportable thereunder by the actual amounts exported under the new licence.

Having taken into account all matters that appear to it to be relevant and having satisfied itself that the proposed interconnection is and will be required by the present and future public convenience and necessity, that its construction is economically feasible, and that no significant adverse environmental impact would result, the Board is prepared to issue a Certificate of Public Convenience and Necessity authorizing the

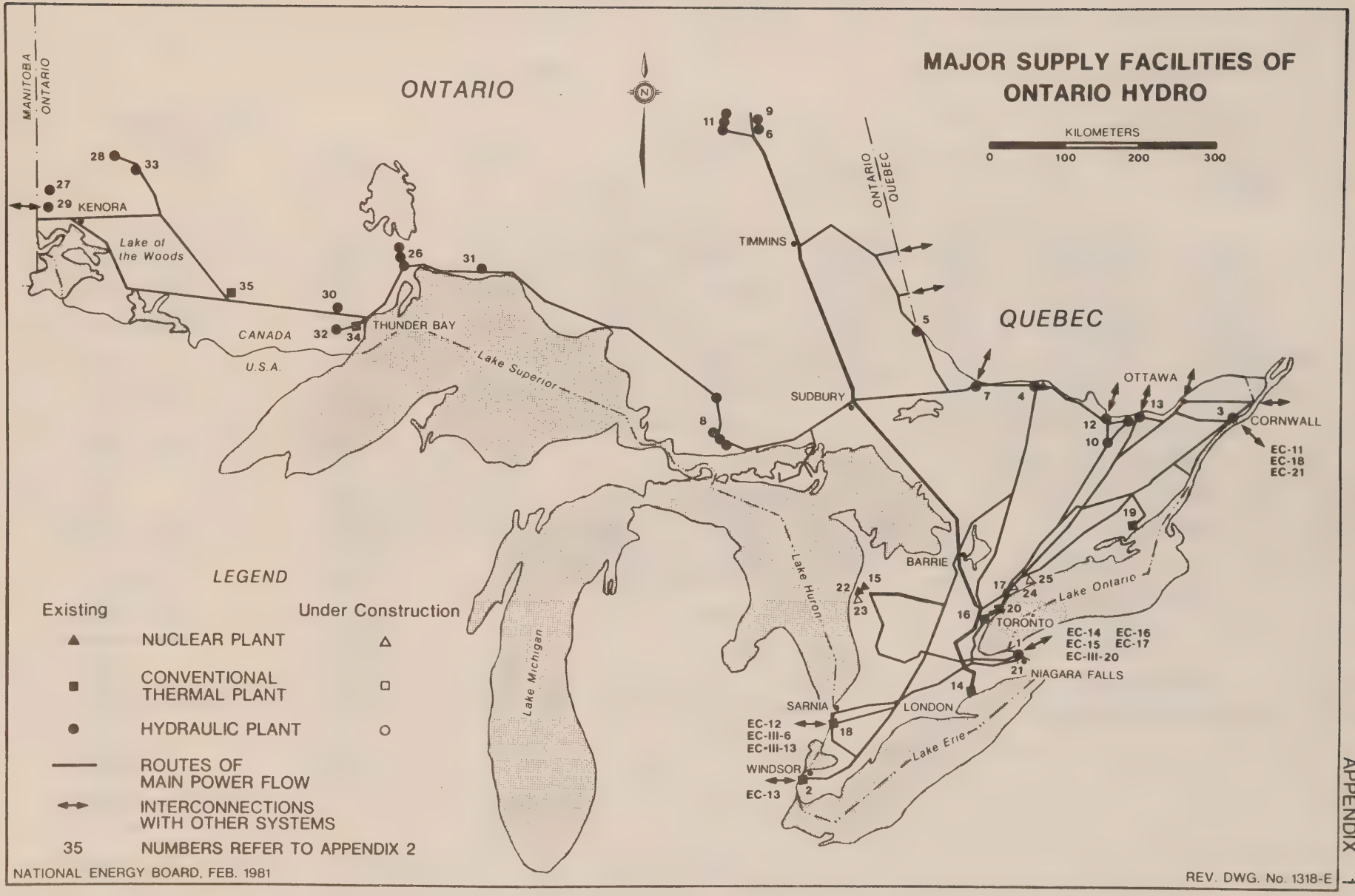
construction and operation of the Canadian portion of the proposed transmission line, subject to the approval of the Governor in Council. Applicable terms and conditions are set out in Appendix 12.

R.F. Brooks
Presiding Member

J.L. Trudel
Member

R.B. Horner, Q.C.
Member

Ottawa, Canada
March, 1982


MAJOR SUPPLY FACILITIES OF ONTARIO HYDRO
ONTARIO
QUEBEC
MANITOBA
ONTARIO
ONTARIO
QUEBEC
KILOMETERS
0 100 200 300
KENORA
Lake of the Woods
CANADA
U.S.A.
THUNDER BAY
Lake Superior
TIMMINS
SUDBURY
OTTAWA
CORNWALL
EC-11
EC-18
EC-21
BARRIE
Lake Huron
Lake Michigan
Lake Ontario
TORONTO
EC-14 EC-16
EC-15 EC-17
EC-III-20
NIAGARA FALLS
SARNIA
LONDON
EC-12
EC-III-6
EC-III-13
WINDSOR
EC-13
Lake Erie
LEGEND
Existing
Under Construction
NUCLEAR PLANT
CONVENTIONAL THERMAL PLANT
HYDRAULIC PLANT
ROUTES OF MAIN POWER FLOW
INTERCONNECTIONS WITH OTHER SYSTEMS
35 NUMBERS REFER TO APPENDIX 2
NATIONAL ENERGY BOARD, FEB. 1981
REV. DWG. No. 1318-E

APPENDIX 1

ONTARIO HYDRO

GENERATING PLANT NAMEPLATE CAPACITY

(megawatts)

EAST SYSTEM

Hydraulic Plants Existing

	Name	River or Location	Capacity
1.	Sir Adam Beck No. 1	Niagara	415
	Sir Adam Beck No. 2	Niagara	1 224
	Pumped Storage	Niagara	177
	Ontario Power	Niagara	101
2.	Decew Falls No.1	Welland Canal	32
	Decew Falls No.2	Welland Canal	115
3.	Saunders	St. Lawrence	912
4.	Des Joachims	Ottawa	360
5.	Lower Notch	Montreal	228
6.	Abitibi Canyon	Abitibi	234
7.	Otto Holden	Ottawa	205
8.	Wells	Mississagi	203
	Rayner	Mississagi	42
	Aubrey Falls	Mississagi	130
	Red Rock Falls	Mississagi	41
9.	Otter Rapids	Abitibi	175
10.	Stewartville	Madawaska	153
	Barrett Chute	Madawaska	152
	Mountain Chute	Madawaska	140
11.	Harmon	Matagami	129
	Kipling	Matagami	125
	Little Long Rapids	Matagami	122
12.	Chenaux	Ottawa	122
13.	Chats Falls	Ottawa	89
	Arnprior	Madawaska	74
	Others, less than 15 MW		136
	Total Hydro East System		5 836

Thermal Plants Existing

	Name	River or Location	Capacity
14.	Nanticoke (coal)	Port Dover	4 000
15.	Bruce A (nuclear)	Kincardine	3 200
16.	Lakeview (coal)	Toronto	2 400
17.	Pickering A (nuclear)	Pickering	2 160
18.	Lambton (coal)	Courtright	2 000
19.	Lennox (oil)	Kingston	2 295
20.	Hearn, R.L. (coal,gas)	Toronto	1 200
21.	Keith, J.C. (coal)	Windsor	264
22.	Douglas Point (nuclear)	Kincardine	200
	Others, less than 100 MW		451
	Total Thermal East System		18 170

Authorized

23.	Bruce B (nuclear)	Kincardine	3 400
24.	Pickering B (nuclear)	Pickering	2 160
25.	Darlington (nuclear)	Bowmanville	3 600
	Others, less than 100 MW		157
	Total Authorized		9 317
	Total Existing East System		24 006

WEST SYSTEM

Hydraulic Plants Existing

	Name	River or Location	Capacity
26.	Pine Portage	Nipigon	129
	Cameron Falls	Nipigon	72
	Alexander	Nipigon	65
27.	Caribou Falls	English	77
28.	Manitou Falls	English	72
29.	Whitedog Falls	Winnipeg	65
30.	Silver Falls	Kaministikwia	45
31.	Aguasabon	Aguasabon	41
32.	Kakabeka Falls	Kaministikwia	24
33.	Ear Falls	English	19
	Total Hydro West System		609

Thermal Plants Existing

34.	Thunder Bay (coal)	100
	Combustion Turbines	28
	Thermal West System	128

Authorized

34.	Thunder Bay Units 2 and 3 (coal)	300
35.	Atikokan (coal) Units 1 and 2	400 (1)
	Total Authorized	700
	Total Existing West System	737

Grand Total Existing 24 743

Numbers refer to locations of generating plants shown on Appendix 1 (Map)

(1) Atikokan G.S. unit 2 has been deferred for an indefinite period.

APPENDIX 2

ONTARIO HYDRO

INTERNATIONAL POWER LINES

Certificate Number	Location	Owner Outside Canada	Operating Designation	Voltage (kV)	Frequency (Hertz)	Nominal Winter Capacity (MVA) (1)
EC-12	Sarnia	Detroit Edison Co.	B3N	230	60	590
EC-13	Windsor	Detroit Edison Co.	J5D	230	60	570
EC-III-6	Courtright	Detroit Edison Co.	L4D	345	60	800
EC-III-13	Courtright	Detroit Edison Co.	L51D	345	60	880
EC-14	Niagara	Niagara Mohawk	BSC105-N	69	25	80
EC-15	Niagara	Niagara Mohawk	BSC105-S	69	25	
EC-17	Niagara	Niagara Mohawk	BSC106-N	69	25	85
EC-17	Niagara	Niagara Mohawk	BSC106-S	69	25	
EC-16	Niagara	Niagara Mohawk	BP76	230	60	550
EC-16	Niagara	PASNY	PA27	230	60	480
EC-18	Cornwall	PASNY	L33P	230	60	360
EC-11,EC-18	Cornwall	PASNY	L34P	230	60	370
EC-21	Cornwall	PASNY	J3BUS (2)	0.6	60	---
EC-III-20	Niagara	PASNY	PA301	345	60	1 410
EC-III-20	Niagara	PASNY	PA302	345	60	1 410

NOTES:

(1) Capacity is the nominal winter capacity of the interconnection. The total permissible interchange with each utility is not the arithmetic sum of the capacities of the interconnections.

(2) The J3BUS is the service bus connecting the Ontario Hydro Saunders generating station to the PASNY Moses (St. Lawrence) generating station.

APPENDIX 3

ONTARIO HYDRO
1981 GENERATION EXPANSION PLAN

(megawatts)[1]

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
EAST SYSTEM																	
Hydro	13	24	16	-	-	53	380	113	149	-	209	248	300	500	-	-	-
Thermal	-	-	-	-	-	-588	-	-	-	-	-591	-	-	-	-	-2286	-
Combustion Turbines	-	28	-	56	-	-	-	-	-	-	-	-	-	-	-	-	-
Supplemental Generation[2]	-	-	-	-	33	33	34	33	33	33	34	33	33	33	34	33	33
Nuclear - Bruce	-	-	1500	-	750	750	-	-	-	-	-	-	-	-	-	-	-
- Pickering	-	516	1032	516	-	-	-	-	-	-	-	-	-	-	-	-	-
- Darlington	-	-	-	-	-	-	881	1762	881	-	-	-	-	-	-	-	-
- E-15 NGS	-	-	-	-	-	-	-	-	-	-	-	850	850	-	850	850	-
ANNUAL TOTAL	13	568	2548	572	783	248	1295	1908	1063	33	-348	1131	1183	533	884	-1403	33
WEST SYSTEM																	
Hydro	6	6	-	-	-	-	-	76	56	-	-	-	-	-	-	-	-
Thermal - Atikokan	-	-	206	-	-	-	206[3]	-	-	-	-	-	-	-	-	-	-
- Thunder Bay	149	-	-	-	-	-	-	-	-	-	-	-	-100	-	-	-	-
Purchases	-150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANNUAL TOTAL	5	6	206	-	-	-	206	76	56	-	-	-	-100	-	-	-	-
TOTAL BOTH SYSTEMS	18	574	2754	572	783	248	1501	1984	1119	33	-348	1131	1083	533	884	-1403	33
CUMULATIVE TOTALS	18	592	3346	3918	4701	4949	6450	8434	9553	9586	9238	10369	11452	11985	12869	11466	11499

NOTES: (1) Figures represent dependable December net peak capacity.
(2) Supplemental generation sources includes co-generation, district heating, refuse burning, and small hydraulic generation.
(3) Atikokan G.S. Unit 2 has been deferred for an indefinite period.

APPENDIX 4

ONTARIO HYDRO

CAPACITY, DEMAND AND SURPLUS
(megawatts)

EAST SYSTEM

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Capacity - Hydro	5 959	5 959	6 012	6 393	6 505	6 654	6 654	6 863	7 111	7 411	7 911	7 911	7 911	7 911
- Thermal	11 973	11 973	11 385	11 385	11 385	11 385	11 385	10 794	10 794	10 794	10 794	10 794	8 508	8 508
- Nuclear	8 812	9 562	10 312	11 192	12 954	13 834	13 834	13 835	14 684	15 535	15 535	16 385	17 235	17 235
Supplemental Generation	-	33	66	100	133	166	199	233	266	299	332	366	399	432
- Gas Turbines	617	617	617	617	617	617	617	617	617	617	617	617	617	617
Purchases	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Dependable Capacity	27 361	28 144	28 392	29 687	31 594	32 656	32 689	32 342	33 472	34 656	35 189	36 073	34 670	34 703
Maintenance	515	515	515	721	515	515	-	-	740	740	740	740	-	-
NET DEPENDABLE CAPACITY	26 846	27 629	27 877	28 966	31 079	32 141	32 689	32 342	32 732	33 916	34 449	35 333	34 670	34 703
Peak Demand (20 minute)	18 645	19 296	19 966	20 654	21 363	22 097	22 824	23 574	24 303	25 058	25 795	26 469	27 077	27 673
Interruptible Load	626	656	656	656	656	656	656	656	656	656	656	656	656	656
Managed Load	-	-	200	400	600	800	1 000	1 200	1 300	1 400	1 500	1 600	1 700	1 800
Net Firm Demand	18 019	18 640	19 110	19 598	20 107	20 641	21 168	21 718	22 347	23 002	23 639	24 213	24 721	25 217
Required Reserve	4 505	4 660	4 777	4 899	5 027	5 161	5 292	5 430	5 587	5 751	5 910	6 053	6 181	6 305
TOTAL DEMAND	22 524	23 300	23 887	24 497	25 134	25 802	26 460	27 148	27 934	28 753	29 549	30 266	30 902	31 522
SURPLUS	4 322	4 329	3 990	4 469	5 945	6 339	6 229	5 194	4 798	5 163	4 900	5 067	3 768	3 181

WEST SYSTEM

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Capacity - Hydro	597	597	597	597	673	729	729	729	729	729	729	729	729	729
- Thermal	604	604	604	810	810	810	810	810	810	710	710	710	710	710
- Gas Turbines	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Purchases	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Dependable Capacity	1 233	1 233	1 233	1 439	1 515	1 571	1 571	1 571	1 571	1 471	1 471	1 471	1 471	1 471
Maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NET DEPENDABLE CAPACITY	1 233	1 233	1 233	1 439	1 515	1 571	1 571	1 571	1 571	1 471	1 471	1 471	1 471	1 471
Peak Demand (20 minute)	1 018	1 052	1 073	1 110	1 149	1 189	1 228	1 268	1 308	1 348	1 388	1 424	1 457	1 489
Interruptible Load	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Managed Load	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Firm Demand	1 018	1 052	1 073	1 110	1 149	1 189	1 228	1 268	1 308	1 348	1 388	1 424	1 457	1 489
Required Reserve	479	467	454	580	570	561	548	539	539	539	540	541	541	541
TOTAL DEMAND	1 497	1 519	1 527	1 690	1 719	1 750	1 776	1 807	1 847	1 887	1 928	1 965	1 998	2 030
SURPLUS	- 264	- 286	- 294	- 251	- 204	- 179	- 205	- 236	- 276	- 415	- 456	- 493	- 526	- 558

NOTES:
(1) Figures are for the month of December, the month in which annual peak load is expected to occur.
(2) East and West Systems peaks are not additive due to diversity.
(3) Supplemental generation sources include co-generation, district heating, refuse burning and small hydraulic generation.
(4) Figures may not add due to rounding.

APPENDIX 5

ONTARIO HYDRO

ANNUAL NET ENERGY CAPABILITIES, LOADS AND SURPLUS

DEPENDABLE STREAMFLOWS

(gigawatt hours)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
TOTAL SYSTEM														
Generation - Hydro	27 273	27 273	27 268	27 509	27 757	28 096	28 315	28 651	28 974	29 170	29 430	29 674	29 602	29 602
- Thermal	81 986	82 065	78 672	79 852	80 038	80 117	80 149	77 691	77 477	76 796	76 796	77 008	62 329	62 329
- Nuclear	54 695	64 312	69 826	72 619	83 979	91 480	99 531	100 697	99 889	107 060	106 555	112 129	120 467	124 232
- Gas Turbines	3 809	3 929	3 929	3 940	3 929	3 929	3 929	3 940	3 929	3 929	3 929	3 940	3 929	3 929
- Supplemental	-	173	347	527	699	872	1 046	1 228	1 398	1 572	1 745	1 929	2 097	2 271
Firm Purchases	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL CAPABILITY	167 763	177 752	180 042	184 447	196 402	204 494	212 970	212 207	211 667	218 527	218 455	224 680	218 424	222 363
Primary Demand	116 474	120 681	124 786	129 481	133 622	138 262	142 820	147 943	152 107	156 821	161 401	166 055	169 407	173 131
ANNUAL SYSTEM SURPLUS	51 289	57 071	55 256	54 966	62 780	66 232	70 150	64 264	59 560	61 706	57 054	58 625	49 017	49 232
Reduction for Locked in Energy	209	1 590	2 123	1 345	-	-	-	-	-	-	-	-	-	-
Reduction for Emission Limits	-	44 341	40 948	42 139	42 314	51 580	51 612	49 164	48 940	48 259	48 259	48 482	33 792	33 792
NET SYSTEM SURPLUS	51 080	11 140	12 185	11 482	20 466	14 652	18 538	15 100	10 620	13 447	8 795	10 143	15 225	15 440

NOTE: Supplemental generation sources include co-generation, district heating, refuse burning and small hydraulic generation.

SUMMARY OF EXPORT PRICE FORMULAE

Capacity Charge Formulae

Capacity Charge (CC) = AMC - R - P - Q, where:

AMC is the levelized annual amortization charge for the Canadian facilities based on Ontario Hydro's costs as capitalized at the in-service date and amortized over the contract term.

R is a take-or-pay factor to compensate Ontario Hydro for coal-fired or other economically-attractive energy made available but not taken by GPU during the Exposure Period. R is computed as:

$$R = (AMC - S \times 10^6) \times \frac{\text{GW.h taken}}{3640}, \text{ where:}$$

S is 19.32$/kW year (U.S.) in 1985 escalating at 10 percent per year thereafter.

"GW.h taken" is the number of GW.h of coal-fired or other economically-attractive energy taken by GPU during an Exposure Period up to a maximum of 3640 GW.h. Energy is economically-attractive to GPU if its cost of production (C) is less than or equal to its value (VC). VC is defined as the cost of modern oil-fired generation in the U.S.

The Exposure Period is to be defined by GPU but includes at least the weekday hours from 8:00 a.m. to 10:00 p.m. It amounts to at least 3640 hours per year and could be larger.

P is a factor to compensate GPU if, during any year, Ontario Hydro is unable to make available 3640 GW.h of coal-fired or other economically-attractive energy during the Exposure Period.

$$P = AMC \times \left[1 - \frac{\text{(GW.h made available during the Exposure Period for which } C \leq VC)}{3640} \right]$$

Q is a factor to compensate GPU if Ontario Hydro is unable to deliver energy due to generation or transmission deficiencies, including outages of the HVDC converter facilities in Ontario.

$$Q = 2 \times AMC \times \left[1 - \frac{\text{(GW.h made available during the Exposure Period)}}{3640} \right]$$

NOTE: The minimum values of R and P are zero.

Energy Charge Formulae

Energy Charge (Price) = $\frac{C + V}{2}$ unless C exceeds V. Than Price = C.

For delivery during an Exposure Period, V = VC as defined below, and C is the cost of coal-fired generation in Ontario, defined as:

$$C = (HR \times ACC \times 10^{-3} + SC + IM) \times (1 + \frac{L}{100}) \times ER, \text{ where}$$

HR (heat rate) = 10,300 Btu per kW.h

ACC is the average cost of coal supply, including interest, in $ per million Btu for Nanticoke, Lakeview, Lambton, Hearn, and Keith generating stations during a given year.

IM is the average incremental maintenance adder in mills per kW.h for Nanticoke, Lakeview, Lambton, Hearn, and Keith generating stations.

SC covers social costs, export taxes, and related costs imposed by the requirement to satisfy environmental regulations.

$$SC = T + \frac{AG}{ACE}, \text{ where:}$$

T = export tax, in mills per kW.h

AG = annual cost, in mills, of acid gas emission controls for coal burning at Nanticoke, Lakeview, Lambton, Hearn, and Keith. This includes both amortization and operating and maintenance costs.

ACE = annual kilowatt hours of coal-fired energy (net sent out) generated at Nanticoke, Lakeview, Lambton, Hearn, and Keith.

L is an allowance for losses in the Ontario Hydro portion of the interconnection.

ER is the exchange rate of the U.S. and Canadian dollars.

For energy supplied from fossil-fired sources other than coal, price equals C and the parameters in the cost equation are based on the specific units supplying the energy. Under these conditions the fuel cost (corresponding to ACC) would be priced according to Ontario Hydro's export licence at the time, plus a 10 percent markup.

VC is computed as:

$$VC = HR \times ACO, \text{ where}$$

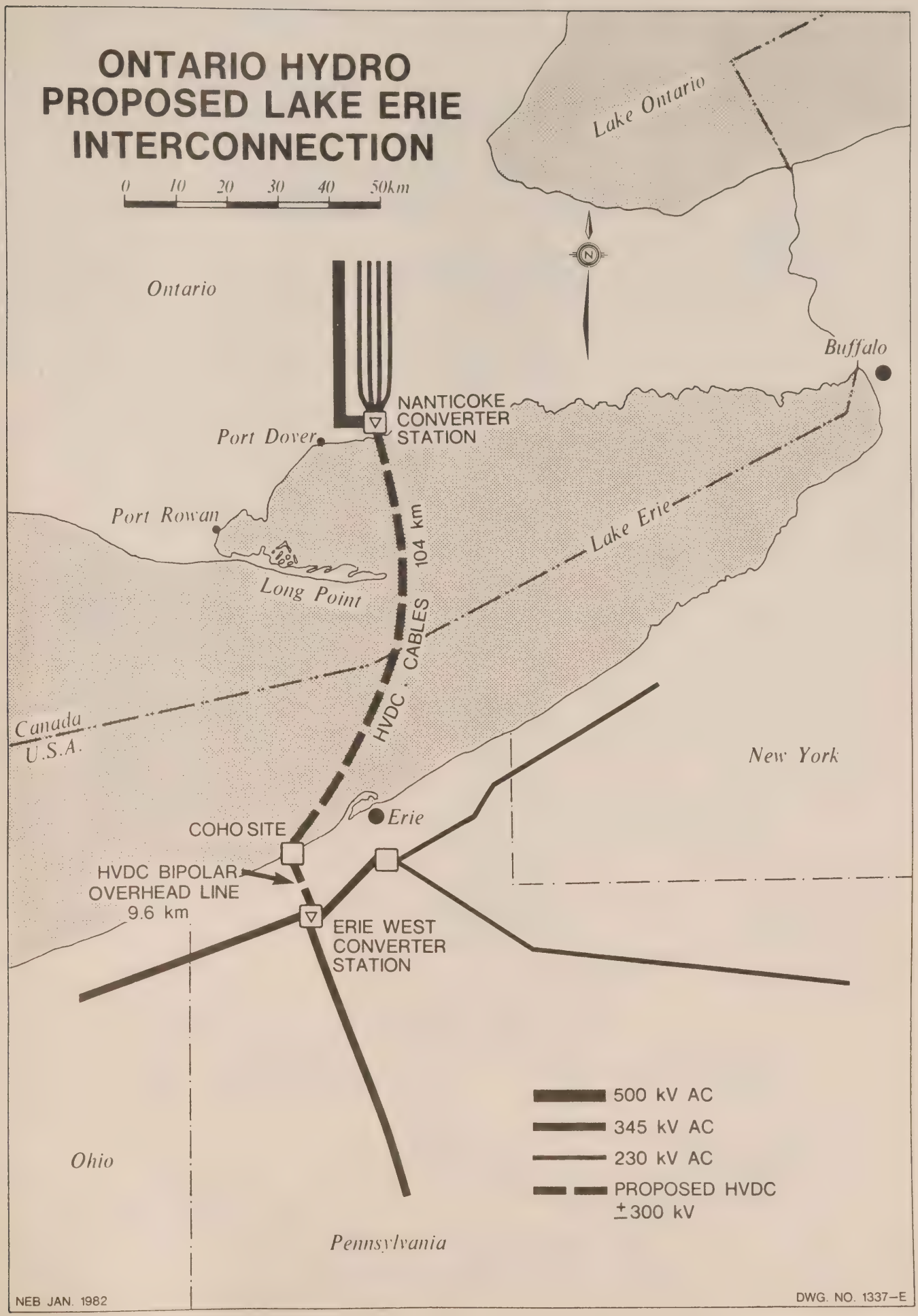
HR (heat rate) = 10 000 Btu per kW.h

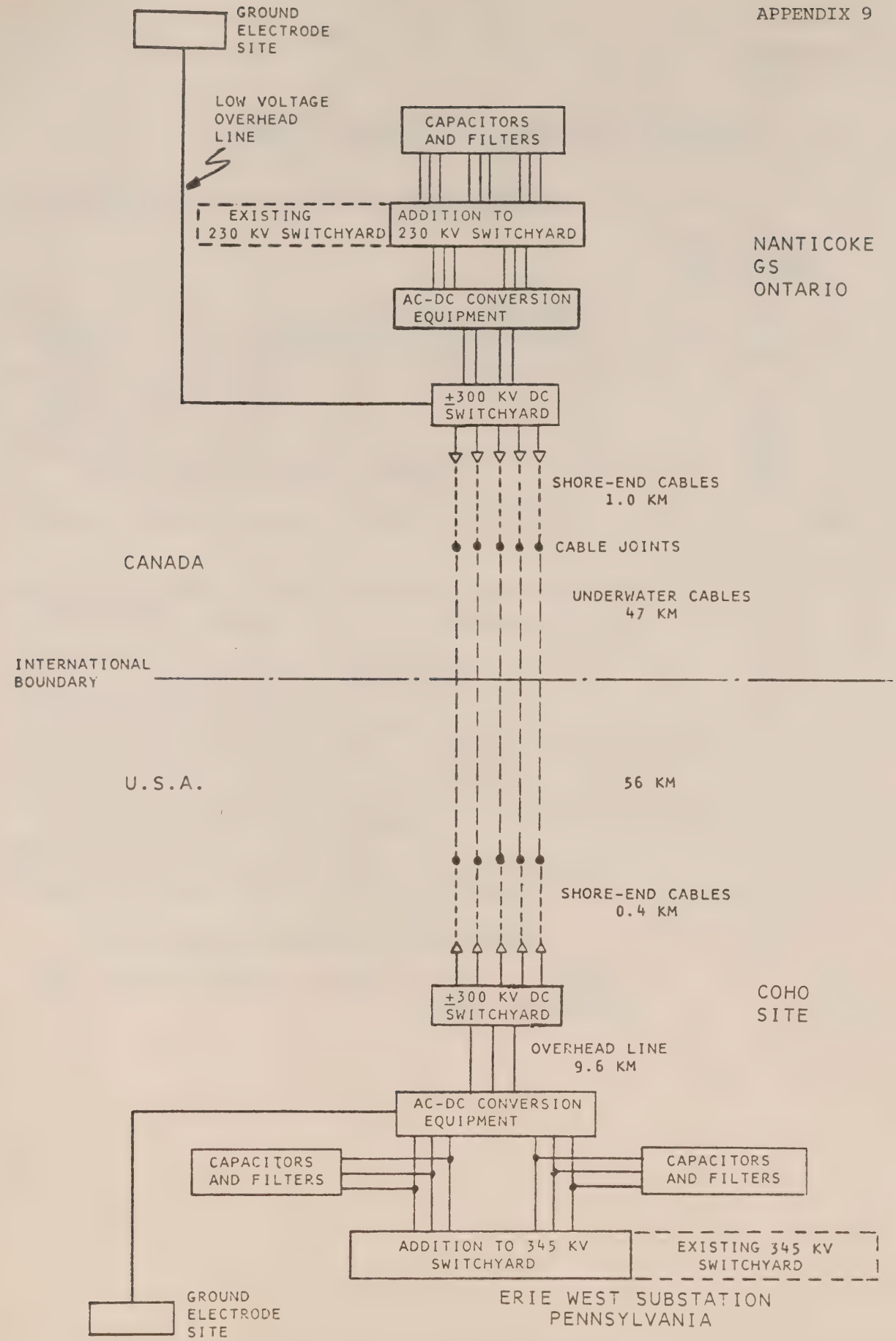
ACO is the average cost of No. 6 fuel oil delivered to New York Harbour, converted to mills per Btu using 6 million Btu per barrel of oil.

If at any time ACO exceeds four times ACC in $U.S. then:

$$VC = HR \times \frac{4 \times ACC \times ER + ACO}{2}$$

Outside the Exposure Period when energy is supplied from nuclear or hydraulic sources, C would be determined using the actual incremental costs and V would be the cost of the most expensive generation on line in the PJM power pool with the exception that V would be no higher than the cost of modern oil-fired generation in the U.S. (VC).


ONTARIO HYDRO
PROPOSED LAKE ERIE
INTERCONNECTION
0 10 20 30 40 50km
Lake Ontario
Ontario
Buffalo
NANTICOKE
CONVERTER
STATION
Port Dover
Port Rowan
Long Point
104 km
HVDC CABLES
Lake Erie
Canada
U.S.A.
New York
Erie
COHO SITE
HVDC BIPOLAR
OVERHEAD LINE
9.6 km
ERIE WEST
CONVERTER
STATION
Ohio
Pennsylvania
500 kV AC
345 kV AC
230 kV AC
PROPOSED HVDC
±300 kV
NEB JAN. 1982
DWG. NO. 1337–E



LAKE ERIE INTERCONNECTION
BLOCK DIAGRAM OF FACILITIES

INTERNATIONAL POWER LINE COST ESTIMATE

Estimated Cost of the HVDC Cable System

	1981 Canadian $ Million	
Submarine cables and accessories, ex-works	215	
Transportation, installation and easement costs for the submarine cables	204	
Supply, transportation and installation of land cables	10	
Lake trials on Lake Erie	18	
System engineering and survey	13	
TOTAL COST OF CABLE SYSTEM	460	
ONTARIO HYDRO'S SHARE OF THE CABLE COSTS		230

Estimated Costs of the Terminal Facilities at Nanticoke

Converters, control and protection	18	
Building for converter facilities	5	
Converter transformers	25	
Direct current smoothing reactors	4	
Alternating current harmonic filters and capacitors	9	
Direct current switching facilities	4	
Alternating current switching facilities including station service transformers	14	
Ground electrode and lines	2	
Telecommunications and supervisory control	1	
System engineering and miscellaneous	8	
TOTAL COST OF TERMINAL FACILITIES	90	
TOTAL COST TO ONTARIO HYDRO ($1981) millions		320
($1984) millions		390

TERMS AND CONDITIONS OF LICENCE FOR THE EXPORT OF FIRM POWER

1. The term of this licence shall commence on the first day of January 1985 and shall end on

   (a) the 31st day of December 1998, or

   (b) ten years from the date at which the international power line to be authorized pursuant to these Reasons for Decision is placed in service at a transfer capacity of at least 1000 MW,

   whichever day shall first occur.

2. Notwithstanding Condition 1, if the international power line to be authorized pursuant to these Reasons for Decision has not been placed in service by 31 December 1986, the term of this licence shall end on that date or upon such later date as may upon application be fixed by the Board.

3. The class of inter-utility export transfer authorized hereunder is the sale transfer of firm and interruptible power and energy.

4. The power to be exported hereunder shall be transmitted over any international power line for which a certificate of public convenience and necessity is in effect.

5. The Licensee shall, prior to the commencement of exports hereunder, submit for the approval of the Board an executed copy of its power supply contract with General Public Utilities Corporation, hereinafter referred to as the "Power Contract", the terms and conditions of which Power Contract shall, except as otherwise authorized by the Board, be identical to the terms and conditions set out in the Principles of Power Supply Contract between Ontario Hydro and General Public Utilities Corporation dated 29 October 1981.

6. After the Board has approved the Power Contract pursuant to Condition 5, the Licensee shall not, without the prior approval of the Board, amend, enter into any agreement in substitution for or in addition to, or terminate, the said Power Contract.

7. All exports made hereunder shall be in accordance with the Power Contract.

8. The quantity of firm power that may be exported hereunder shall not exceed 1000 megawatts.

9. The quantity of energy that may be exported hereunder shall not exceed 8760 gigawatt hours in any calendar year.

10. Notwithstanding the requirements of Condition 8, and subject to the requirements of Condition 11, the maximum rate of transfer of the annual quantity of energy set out in Condition 9 shall not exceed 1200 megawatts.

11. The additional allowable rate of transfer of the allowable energy export set out in Condition 9, over and above the maximum firm power export of 1000 megawatts, shall be interrupted or curtailed whenever and to whatever extent such power is required to supply Canadian customers on any interconnected power system.

12. The Licensee shall interrupt or curtail the delivery of energy hereunder whenever and to whatever extent such energy is required to supply any firm load in Ontario.

13. For energy generated by the burning of fuel oil, the incremental fuel cost used in any pricing formula under the Power Contract referred to in Condition 5 shall be

    (a) for imported fuel oil, the price paid by the Licensee plus the amount by which that price was reduced by any subsidy or compensation payment from any level of government in Canada,

    (b) for fuel oil made from Canadian crude, the export price of such Canadian fuel oil, including any export charge.

14. The Licensee shall, within 15 days after the end of each month comprised in the term of this licence, file with the Board a report in such form and detail as the Board may specify, setting forth for that month information pertaining to emissions of oxides of nitrogen and sulphur dioxide resulting from the Licensee's operations.

15. The Licensee shall, within 15 days after the end of each month comprised in the term of this licence, file with the Board a report in such form and detail as the Board may specify, setting forth for that month information pertaining to transactions under the licence.

TERMS AND CONDITIONS OF CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY

1. The international power line to be constructed pursuant to this certificate shall be owned and operated by Ontario Hydro.

2. The international power line shall consist of five direct current cables insulated for 300 kV operation, the AC to DC converter facilities located at Nanticoke Switch Yard, and a ground electrode line and ground electrode to be located pursuant to Condition 10.

3. The five 300 kV cables forming part of the international power line, shall be located in a corridor as shown in Exhibit 59 of the application, extending from Nanticoke Switch Yard to a point on the international boundary located in Lake Erie, approximately at latitude 45° 25' 43.5" north, longitude 79° 59' 20.4" west, a distance of approximately 48 kilometres.

4. The international power line shall connect, at the point on the international boundary referred to in Condition 3, with facilities similar in function to those authorized hereunder to be constructed by General Public Utilities Corporation or its subsidiary company, hereinafter referred to as GPU.

5. Ontario Hydro shall file, for the approval of the Board, material demonstrating to the satisfaction of Ontario Hydro the ability of GPU to finance the facilities to be constructed by it and to finance the transactions set out in the Principles of Power Supply Contract dated 29 October 1981 between Ontario Hydro and GPU, which approval shall be obtained before major orders are placed for equipment forming part of the international power line.

6. Ontario Hydro shall file, for the approval of the Board, an executed copy of its construction agreement with GPU, which approval shall be obtained before construction of the line is commenced.

7. Ontario Hydro shall file, for the approval of the Board, updates, including any updates to the construction schedule, to the report on the preliminary project environmental requirements dated December 1981 which was filed with the Board as Exhibit 65 at the hearing.

8. Ontario Hydro shall implement or cause to be implemented both during and after the construction of the international power line the recommendations and practices for the protection of the environment as adduced in evidence before the Board.

9. Ontario Hydro shall file, for the approval of the Board, its detailed plan for ensuring public participation, including a list of the parties to be contacted, the nature of the information to be distributed, and the methods for incorporating responses from the public, in regard to its procedure for selecting a site for the ground electrode and a route for the ground electrode conductor.

10. Ontario Hydro shall file, for the approval of the Board, the proposed route and design of the ground electrode line, and the proposed location and design of the ground electrode, including

    (a) a map showing the location and ownership of all facilities within 25 kilometres of the proposed site which could potentially be affected by the electrode construction and operation,

    (b) the measures proposed to mitigate or eliminate potential effects, and

    (c) a report assessing all alternative ground electrode sites considered and setting out the reasons for selecting the preferred site,

    which approval shall be obtained prior to the commencement of construction of the ground electrode and associated facilities.

11. The current carried by the ground electrode shall be held as close to zero as possible

    (a) under bipolar operation, by operating the two poles of the interconnection to carry as close to equal loads as is controllable, and

    (b) under monopolar operation, by switching spare or unloaded conductors into the return circuit as quickly as possible.

12. The ground electrode shall not, unless otherwise authorized by the Board, carry currents greater than ten amperes for cumulative periods longer than 12 hours in any consecutive 12-month period.

13. Ontario Hydro shall file with the Board, no later than one year after the facilities authorized hereunder are energized, and annually thereafter, a report setting forth

    (a) the time, duration, and cause of forced outages of any of the facilities comprising the interconnection with GPU which resulted in ground currents greater than 20 amperes,

    (b) the time required after each of the said forced outages to reduce the ground current to less than 20 amperes, and

    (c) a description of unresolved problems, if any, relating to safety, corrosion, incorrect operation of facilities in Canada, or any other effect on the environment attributed to operation of the interconnection.

14. Ontario Hydro shall file, for the approval of the Board, a description and diagram of the metering facilities proposed in association with the international power line, which approval shall be obtained before the metering facilities are installed.

15. Ontario Hydro shall not make any changes in the international power line or in the associated metering facilities without the prior approval of the Board.

16. If the international power line has not been placed in service by 31 December 1986, the certificate shall expire on that date or upon such later date as may upon application be fixed by the Board.